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Diatoms from the Vaal Dam Catchment Area Transvaal, South Africa

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The Vaal Dam is of great importance to South Africa as it ensures a good supply of water to the Witwatersrand complex, South Africa's most important industrial and mining centre, and the problem of pollution and protection of the waters flowing into this dam is therefore of very great significance. Consequently, in 1955 the "Special Sub-committee on Stream Surveys in the Witwatersrand" (organised by the National Institute for Water Research) recommended that a survey of the Vaal Dam Catchment Area should be undertaken (Malan 1960: 1). The objects of this survey were to gather background knowledge of the conditions in this area, and to study the factors that affect the quality of the water in the rivers and streams running into the Vaal Dam.

Subsequently Malan (1960) undertook a survey of the area with regard to the chemical quality of the surface waters of the catchment area. In his report on this survey Malan recommended that from a biological point of view „the flora and fauna of the main river systems should be evaluated with a view to assessing pollution effects accurately and determining the effects of changing industrial and agricultural activity". In fulfilment of this recommendation Chutter (1967) completed the studies on the fauna of the catchment area, and this report is presented as a contribution towards the survey of the Vaal Dam Catchment Area.

The catchment area of the Vaal Dam covers an area of approximately 38.000 square kilometers to the south and south-east of Johannesburg, and is a large, relatively shallow basin. The greater part of the catchment area is flat, gently undulating grassland lying at an altitude of between 1300 and 1580 meters above sea level (Chutter 1967: 47). The highest ground lies in the south where the Elands River rises on the northern slopes of Mont-aux-Sources in the Drakensberg. The catchment area consists of two main water courses (see Map 1), the Vaal River and its tributaries draining the more easterly regions of the catchment area, and the Wilge River draining the more westerly regions. For convenience the catchment area was divided into four river systems, which are referred to in the text as the Vaal River System, the Klip River System, the Waterval River System and the Wilge River System. The Vaal River System is composed of the Vaal River and its tributaries down to the confluence of the Klip River just below Standerton; the Klip River System embraced the Klip River and its tributaries above the confluence of the Klip and Vaal Rivers; the Waterval River System included the Waterval River and its tributaries together with the lower parts of the Vaal River; and finally the Wilge River System comprising the Wilge River and all its tributaries.

The material for the investigation was collected on a number of different occasions by Dr. B. J. Cholnoky, Dr. F. M. Chutter and the author. In July 1957 and July 1958 a series of samples, numbered in the range Vaal 200—299, were collected by Cholnoky from the Wilge River System. During the entire period of the survey, i. e. from 1958 to 1960, Chutter made irregular collections of a large number of diatom samples from his sampling stations (Chutter 1967: 57, Table 11 and Fig. 9); these samples were numbered in the series Vaal 300—399. In August 1960 Cholnoky made a further collection of samples, Vaal 400—499, from the Vaal, Klip and Waterval River Systems. Finally the author, while on a trip round the catchment area, made a small collection of diatom material (Vaal 500 onwards) of which only a few were examined and analysed.

The distribution of the sampling points is shown on Map 1. The numbers enclosed within a square refer to Chutter's sampling stations (Chutter 1967: Fig. 9), and the numbers written alongside them refer to the samples collected at that point. Sampling points, which did not coincide with any of Chutter's stations, are indicated by a black dot next to which the sample numbers collected at that point are noted. In the text any sampling point designated "Station" refers to Chutter's sampling stations.

In the list below, brief descriptions of the samples, sampling stations and sampling points are given.

Vaal 203 — A large river near the Witzieshoek Reserve on the road from Kestell to Witzieshoek. 24. 7. 57.

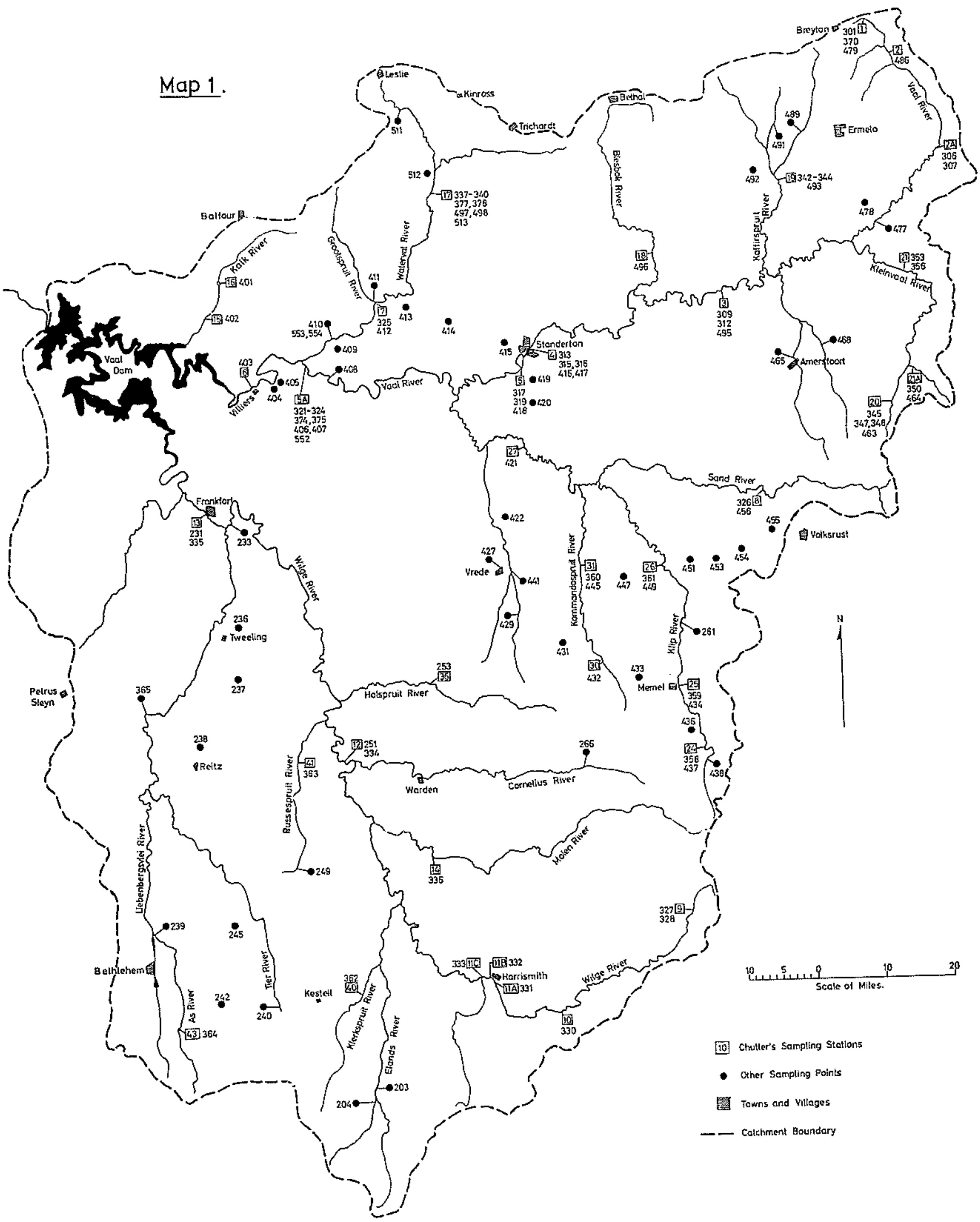
Vaal 204 — A swiftly flowing river nearer to the Witzieshoek Reserve. 24. 7. 57.

Vaal 231 — The Wilge River at Frankfort. Station 13 of Chutter. 11. 7. 58.

Vaal 233 — The Wilge River south of Frankfort, above the bridge on the Frankfort—Reitz road. 11. 7. 58.

Vaal 236 — A small stream near the village of Tweeling on the Frankfort—Reitz road. 11. 7. 58.

Vaal 237 — Another small river south of Tweeling on the Tweeling—Reitz road. 11. 7. 58.



The Sampling Points and Stations of the Vaal Dam Catchment Area.

Vaal 238 — A large river about 5 km north of Reitz on the Tweeling—Reitz road. 11. 7. 58.

Vaal 239 — The Liebenbergsvlei River between Bethlehem and Reitz. 11. 7. 58.

Vaal 240 — A marshy river about 16 km from Kestell on the Kestell—Bethlehem road. This is probably the Tier River. Ice was present on the water surface. 12. 7. 58.

Vaal 242 — A large tributary of the As River, about 24 km east of Bethlehem on the Kestell—Bethlehem road. 12. 7. 58.

Vaal 245 — A small tributary of the Tier River on the Bethlehem — Warden road, near the Sherbrooke Station. 12. 7. 58.

Vaal 249 — A small spring on the side of the road about 32 km west of Warden on the Bethlehem—Warden road. Probably the Russespruit stream. 12. 7. 58.

Vaal 253 — The Holspruit, swiftly flowing, where it is crossed by the Vrede—Warden road. 12. 7. 58.

Vaal 261 — The Seekoeivlei near Memel. 13. 7. 58.

Vaal 266 — The Cornelis River, 29 km south of Memel on the Memel—Harrismith road. 13. 7. 58.

Vaal 301 — The headwaters of the Vaal River between Breyten and Lake Chrissie. Station 1 of CHUTTER. 16. 9. 58.

Vaal 306 — The Vaal River where it is crossed by the Ermelo—Amsterdam road. Marginal mud. Station 2A of CHUTTER. 22. 7. 59.

Vaal 307 — The same locality as Vaal 306. Stones in Current. 19. 1. 60.

Vaal 309 — The Vaal River where it is crossed by the Morgenzon—Amersfoort road. Station 3 of CHUTTER. 15. 9. 58.

Vaal 312 — The same locality as Vaal 309. Stones in current. 23. 9. 59.

Vaal 313 — The Vaal River at Standerton. Below the creamery effluent. Station 4 of CHUTTER. 15. 9. 58.

Vaal 315 — The same locality as Vaal 313. Stones in current. 22. 9. 59.

Vaal 316 — The same locality as Vaal 313. Stones in current. 19. 1. 60.

Vaal 317 — The Vaal River below Station 4, below the Sewage Works at Standerton. Station 5 of CHUTTER. 15. 9. 58.

Vaal 319 — The same locality as Vaal 317. Stones in current. 22. 9. 59.

Vaal 321 — The Vaal River where it is crossed by the Staderton—Villiers road. Station 5A of CHUTTER. Stones in current. 20. 7. 59.

Vaal 322 — The same locality as Vaal 321. Algae trailing in the current. 18. 8. 59.

Vaal 323 — The same locality as Vaal 321. Algae trailing in the current. 22. 9. 59.

Vaal 324 — The same locality as Vaal 321. Stones in current. 19. 1. 60.

Vaal 325 — The Waterval River where it is crossed by the Balfour—Standerton road. Station 7 of CHUTTER. 10. 9. 59.

Vaal 326 — The Sandspruit stream at Sandspruit on the national road from Standerton to Volksrust. Station 8 of CHUTTER. 16. 9. 58.

Vaal 327 — The headwaters of the Wilge River, where it is crossed by the Harrismith—Colling's Pass road. Station 9 of CHUTTER. 15. 10. 58.

Vaal 328 — The same locality as Vaal 327. Stones in current. 9. 12. 58.

Vaal 330 — The Wilge River at Swinburne. Station 10 of CHUTTER. 17. 9. 58.

Vaal 331 — The Wilge River at the bridge at its entrance to Harrismith. Station 11A of CHUTTER. 17. 9. 58.

Vaal 332 — The Wilge River where it leaves Harrismith. Station 11B of CHUTTER. 17. 9. 58.

Vaal 333 — The Wilge River a little below Harrismith. Station 11C of CHUTTER. 14. 10. 58.

Vaal 334 — The Wilge River where it is crossed by the road from Warden to Harrismith. Station 12 of CHUTTER. 15. 9. 58.

Vaal 335 — The Wilge River at Frankfort. Station 13 of CHUTTER. 18. 9. 58.

Vaal 336 — The Molen River where it is crossed by the Warden—Harrismith road. Station 14 of CHUTTER. 17. 9. 58.

Vaal 337 — The Waterval River where it is crossed by the Standerton—Leslie road at Roodebank. Stones in current. Station 17 of CHUTTER. 20. 7. 59.

Vaal 338 — The same locality as Vaal 337. 22. 9. 59.

Vaal 339 — The same locality as Vaal 337. Stones in current. 19. 1. 60.

Vaal 340 — The same locality as Vaal 337. Marginal vegetation. 19. 1. 60.

Vaal 342 — The Kaffirspruit stream where it is crossed by the Morgenzon—Ermelo road. Station 19 of CHUTTER. 15. 9. 58.

Vaal 343 — The same locality as Vaal 342. Stones in current. 22. 7. 59.

Vaal 344 — The same locality as Vaal 342. 20. 1. 60.

Vaal 345 — From a seepage on a bank of a headwaters tributary of the Kleinvaal River. 10. 12. 58.

Vaal 347 — A headwaters tributary of the Kleinvaal River. Stones in current. Station 20 of CHUTTER. 23. 9. 59

Vaal 348 — The same locality as Vaal 347. 20. 1. 60.

Vaal 350 — The Kleinvaal River near Station 20. Station 21A of CHUTTER. 23. 9. 59.

Vaal 353 — The Kleinvaal River near its confluence with the Vaal River. Station 21 of CHUTTER. Muddy margin. 23. 9. 59.

Vaal 356 — The same locality as Vaal 353. Stones in current. 20. 1. 60.

Vaal 358 — The Klip River on the road up Müller's Pass between Memel and Newcastle. Station 24 of Chutter. Stones in current. 13. 1. 59.

Vaal 359 — The Klip River at Memel. Station 25 of Chutter. Stones in current. 14. 1. 59.

Vaal 360 — The Kommandospruit stream where it is crossed by the Vrede—Volksrust road. Station 31 of Chutter. 14. 1. 59.

Vaal 361 — The Klip River where it is crossed by the Vrede—Volksrust road. Station 26 of Chutter. 14. 1. 59.

Vaal 362 — The Klerkspruit Stream where it is crossed by the Harrismith—Kestell road. Station 40 of Chutter. 14. 10. 58.

Vaal 363 — The Russespruit Stream where it is crossed by the Warden—Reitz road. Station 41 of Chutter. 9. 2. 59.

Vaal 364 — Headwaters of the As River, south of Bethlehem. Station 43 of Chutter. 18. 11. 58.

Vaal 365 — The Liebenbergsvlei River where it is crossed by the Reitz—Petrus Steyn road. Station 44 of Chutter. 17. 11. 58.

Vaal 370 — The headwaters of the Vaal River, between Breyten and Lake Chrissie. Station 1 of Chutter. 21. 3. 60.

Vaal 374 — The Vaal River where it is crossed by the Standerton—Villiers road. Station 5A of Chutter. 3. 6. 60.

Vaal 375 — The same locality as Vaal 374. Algae trailing in the water. 3. 6. 60.

Vaal 377 — The Waterval River where it is crossed by the Leslie—Standerton road. Station 17 of Chutter. 6. 5. 60.

Vaal 378 — The same locality as Vaal 377. 3. 6. 60.

Vaal 401 — Grootvlei, the Springfield Colliery dam on the Kalk River. Station 16 of Chutter. pH 8.5. 8. 8. 60.

Vaal 402 — The Kalk River below Grootvlei, where it is crossed by the Heidelberg—Villiers road. Station 15 of Chutter. pH 8.7. 8. 8. 60.

Vaal 403 — The Vaal River below the national road bridge at Villiers. pH 8.6. 8. 8. 60.

Vaal 404 — A small stream east of Villiers, about 5 km on the road to Standerton. The stream was in the process of drying up and was not flowing. pH 8.6. 8. 8. 60.

Vaal 405 — Another small tributary 1.5 km further along this road. Large pools in a dry river bed. pH 8.7. 8. 8. 60.

Vaal 406 — The Vaal River where it is crossed by the Standerton—Villiers road. Station 5A of Chutter. Stones in current. pH 8.7. 8. 8. 60.

Vaal 407 — The same locality as Vaal 406. Slow flowing water on the banks of the river. pH 8.7. 8. 8. 60

Vaal 408 — A small stream about 2 miles east of Vaal 406. Rocky bottom and there was no flowing water. pH 8.6. 8. 8. 60.

Vaal 409 — A small marshy stream between Vaal 406 and Standerton. Large quantities of algae were present on the water surface. 8. 8. 60.

Vaal 410 — The Waterval River between Vaal 406 and Standerton. Sample taken from below the road bridge. pH 8.5. 8. 8. 60.

Vaal 411 — The Grootspruit stream near the Balfour—Standerton road, just before its confluence with the Waterval River. pH 8.7. 8. 8. 60.

Vaal 412 — The Waterval River where it is crossed by the Balfour—Standerton road. Station 7 of Chutter. pH 8.7. 8. 8. 60.

Vaal 431 — A small stream between Vaal 412 and Standerton. The water was flowing very slowly. pH 8.8. 8. 8. 60.

Vaal 414 — Another small stream nearer Standerton. Large masses of *Oedogonium* were present. pH 9.6. 8. 8. 60.

Vaal 415 — A small stream 5 miles west of Standerton on the Balfour—Standerton road. pH 8.5. 8. 8. 60.

Vaal 416 — The Vaal River at Standerton, below the old railway bridge and below the milk processing factory. Station 4 of Chutter. pH 8.2. 8. 8. 60.

Vaal 417 — A small stream near Vaal 416; probably drains the area around the milk processing factory. pH 8.2. 8. 8. 60.

Vaal 418 — The Vaal River below the Standerton Sewage Works. Station 5 of Chutter. The river bed is granite rock. pH 8.5. 8. 8. 60.

Vaal 419 — The first small stream outside Standerton on the road to Vrede. pH 8.7. 9. 8. 60.

Vaal 420 — The second small stream on the same road. 9. 8. 60.

Vaal 421 — The Klip River at de Lange's Drift near the bridge on the Standerton—Vrede road. pH 8.3. 9. 8. 60.

Vaal 422 — A small stream between de Lange's Drift and Vrede. pH 8.5. 9. 8. 60.

Vaal 427 — A small stream on the northern boundary of Vrede. pH 9.0. 9. 8. 60.

Vaal 429 — The Klipspruit Stream between Vrede and Memel. pH 8.7. 9. 8. 60.

Vaal 431 — The Maddenspruit Stream between Vrede and Memel. pH 8.5. 9. 8. 60.

Vaal 432 — The Kommandospruit Stream between Vrede and Memel. pH 8.6. 9. 8. 60.

Vaal 433 — A small spring at the side of the road between the Kommandospruit stream and Memel. pH 7.0. 9. 8. 60.

Vaal 434 — The Klip River just above Memel. pH 8.4. 9. 8. 60.

Vaal 436 — The Dwarsspruit between Memel and Müller's Pass. pH 7.4. 9. 8. 60.

Vaal 437 — The Klip River between Memel and Müller's Pass. pH 8.1. 9. 8. 60.

Vaal 438 — A marsh alongside the road about 3 km from Müller's Pass. pH 7.4. 9. 8. 60.

Vaal 441 — The River flowing from Vrede Dam. pH 8.5. 10. 8. 60.

Vaal 445 — The Kommandospruit Stream where it is crossed by the Vrede—Volksrust road. pH 8.4. 10. 8. 60.

Vaal 447 — A very small stream between Vaal 445 and Vaal 449. pH 8.6. 10. 8. 60.

Vaal 449 — The Klip River where it is crossed by the Vrede—Volksrust road. Station 26 of CHUTTER. pH 8.3. 10. 8. 60.

Vaal 451 — A small stream between Vaal 449 and Volksrust. pH 8.2. 10. 8. 60.

Vaal 453 — A very small stream near Volksrust. The stream was in the process of drying up. pH 8.5. 10. 8. 60.

Vaal 454 — An unnamed river where it is crossed by the Vrede—Volksrust road. pH 8.5. 10. 8. 60.

Vaal 455 — A small stream west of Volksrust on the road to Vrede. pH 8. 2. 10. 8. 60.

Vaal 456 — The Sandspruit River where it is crossed by the Volksrust—Amersfoort road. Station 8 of CHUTTER. pH 8.3. 10. 8. 60.

Vaal 463 — A small headwaters tributary of the Kleinvaal River. Station 20 of CHUTTER. pH 8.5. 10. 8. 60.

Vaal 464 — The Kleinvaal River between Amersfoort and Wakkerstroom. Station 21 A of CHUTTER. pH 8.3. 10. 8. 60.

Vaal 465 — The Skulpspruit Stream near Amersfoort. pH 8.2. 11. 8. 60.

Vaal 468 — The Rietspruit Stream between Amersfoort and Sheepmoore. pH 8.5. 11. 8. 60.

Vaal 477 — The Vaal River just above the confluence of the Vaal and the Kleinvaal Rivers. pH 7.9. 11. 8. 60.

Vaal 478 — A marsh between Vaal 477 and Ermelo, on the farm Welgelegen. pH 8.3. 11. 8. 60.

Vaal 479 — The headwaters of the Vaal River between Breyten and Lake Chrissie. Station 1 of CHUTTER. pH 6.8; 6.0; 6.3. 11. 8. 60.

Vaal 485 — Lake Chrissie.

Vaal 486 — The Vaal River between Lake Chrissie and Ermelo. Water flowing slowly over a rocky river bed. pH 8.0. 11. 8. 60.

Vaal 489 — The Kleinkaffirspruit Stream near Ermelo. pH 9.2. 12. 8. 60.

Vaal 491 — The Kaffirspruit between Ermelo and Bethal. Shallow water on a rocky bed. pH 8.6. 12. 8. 60.

Vaal 492 — A small tributary of the Kaffirspruit stream between Ermelo and Standerton, on the property Nelspan 4. pH 8.4. 12. 8. 60.

Vaal 493 — The Kaffirspruit Stream between Ermelo and Standerton. Station 19 of CHUTTER. Sandstone rocks pH 8.1. 12. 8. 60.

Vaal 495 — The Vaal River where it is crossed by the Morgenzon—Amersfoort road. Station 3 of CHUTTER. pH 8.5. 12. 8. 60.

Vaal 496 — The Blesbok River between Morgenzon and Standerton. Station 18 of CHUTTER. Sandstone bed. pH 8.5. 12. 8. 60.

Vaal 497 — The Waterval River where it is crossed by the Standerton — Leslie road at Roodebank. Station 17 of CHUTTER. A waterfall on a sandstone base. pH 9.4. 12. 8. 60.

Vaal 498 — The same locality as Vaal 497, but the sample was collected from above the waterfall, where the water was flowing very swiftly.

Vaal 511 — The Waterval River, 11 km from Leslie on the Leslie—Standerton road. Cattle drink here. pH 8.0. 15. 3. 65.

Vaal 512 — The Kaffirspruit stream where it is crossed by the Leslie—Standerton road. About 27 km from Leslie. 15. 3. 65.

Vaal 513 — The Waterval River where it is crossed by the Leslie—Standerton road at Roodebank. Station 17 of CHUTTER. pH 8.4. 15. 3. 60.

Vaal 552 — The Waterval River where it is crossed by the Villiers—Standerton road at Gladdedrift. Station 5A of CHUTTER. pH 8.2. 19. 3. 65.

Vaal 553 — The Waterval River where it is crossed by the Villiers—Greylingstad road. 19. 3. 65.

Vaal 554 — The Waterval River where it is crossed by the Villiers—Greylingstad road. A seepage from the river bank. 19. 3. 65.

A list of the diatoms, in alphabetical order, found in these samples is given below, together with some taxonomic and ecological comments on the more interesting species. In cases where the occurrence of a particular species was very rare only the numbers of the sampling points at which it was found have been given, unless some feature of the species warranted comment.

Achnanthes BORY 1822.

A. adamantiformis ARCHIBALD nov. comb.

This species was first described as a small *Navicula*, *N. adamantiformis* (ARCHIBALD 1966a: 256, F. 5, 6), as only the raphovalve had been studied. Later, however, cells were found containing both areo- and raphovalves. It was quite evident, therefore, that this was not a *Navicula* and must be redescribed as a new species of Achnanthes. These forms bear a resemblance to *A. latissima* CLEVE-EULER (cf. HUSTEDT 1927—1964: 389, F. 835) but differs from it in shape, having slightly protracted poles, in its size and finer striation of the valve wall. It also has some slight similarity to *Achnanthes montana* KRASSKE (cf. HUSTEDT l. c.: 398, F. 847) and *A. lacunarum* HUSTEDT (l. c.: 398, F. 848), but again the new species differs in the structure of the valves and its dimensions.

The valves of *A. adamantiformis* are broadly rhombic-elliptical with, in most cases, slightly apiculate or rost-

rate poles. The length of the valves is 6—6.5 μ, and the width 4.5—5 μ. The raphovalve: the raphe branches are straight and filiform and have extremely widely separated central pores (about one third of the valve length between the two central pores); due to shortening of the transapical striae, the axial area and central area combine to form a large wide lanceolate area; the transapical striae are radial throughout, extending about one third of the way into the valve, and becoming more radial towards the poles, about 21—24 striae in 10 μ; irregularly shortened striae are usually present. The areovalve: in contrast with the raphovalve, the areovalve has a narrow linear axial area or pseudoraphe; the transapical striae are radial throughout and extend right to the apical axis, thus forming a very narrow pseudoraphe, and number about 21—24 in 10 μ; there are no shortened striae in the areovalve. The longitudinal costae are occasionally just visible.
The species was found in small numbers in the Waterval River and in one sample from the Vaal River. *A. adamantiformis* is not known well enough to comment on its autecology.
Figures 1—5.
Samples — 316, 324, 339, 340, 401, 403, 553.

A. coarctata (Brébisson) Grunow (cf. Hustedt 1927 bis 1964, Teil **2**: 419, F. 827a—c).
This species has been found over quite a widespread area of South Africa, particularly in oligotrophic rivers with low pH values; under such conditions this species appears to find its optimum development. In this study it occurred in the Kaffirspruit and Kleinvaal Rivers as single isolated specimens and cannot, therefore, be regarded as autochthonous.
Samples — 353, 489.

A. cogitata n. sp.
This species can only be related to *A. adamantiformis* described above. It might be better to regard these two valves as a veriety of *A. adamantiformis*; however, it differs from the latter in two respects. The raphovalve of *A. cogitata* contains a narrowly linear axial area with no indication of a central area, while in *A. adamantiformis* the axial and central areas combine to form a very wide lanceolate space covering one third of the valve surface. The areovalve also differs in structure and has a linear axial area, which widens in the middle forming an oval central area. It has not been found possible to associate this species with any other Achnanthes species known to the author.
The valves are rhomboidal in shape with rounded ends, which are not protracted; about 6 μ in length and 4 μ broad. The raphovalve has a straight filiform raphe composed of very short branches, so that the central pores are relatively very widely separated (about one third of the length of the apical axis of the valve). The central pores and terminal fissures are inconspicuous. The areovalve has a narrower linear axial area widening in the centre into an oval central area. On both valves there are 24 transapical striae in 10 μ, and these are radial throughout. In the raphovalve there are one or two shortened striae. The longitudinal costae are too fine to be observed. Figures 6, 7.
Valvae rhomboideo-lanceolatae, apicibus conice attenuatis, regulariter rotundatis, non protractis, circiter 6 μ longae, 4 μ lataeque. Raphovalva; raphe directa, filiformis, poris centralibus valde distantibus, itaque fissuris brevibus. Distantia pororum centralium circiter tertiam partem longitudiins valvae occupat. Pori centrales terminalesque parvi, indistincti. Area axialis anguste linearis, centralis nulla sive abbreviatione striarum medianarum levissime significata. Areovalva: area axialis anguste linearis, in media parte valvae abbreviatione regulare striarum nonnullarum in aream centralem ellipticam transiens. Striae transapicales utraeque valvae in tota longitudine superficiei radiantes, 24 in 10 μ, in raphovalva ad nodulum centralem singulis intercalatis brevioribus. Costae longitudinales invisibiles.
Habitat: in rivo Waterval River sub ponte viae publicae inter pagos Standerton et Greylingstad Africae Meridionalis.
Typus: praeparatus no. 412 in collectione C. S. I. R., Pretoria.
Iconotypus: figurae nostrae no. 6 et 7.

A. Engelbrechtii Cholnoky (1955a: 16, F. 1—8).
As this species prefers alkaline brackish water (Cholnoky 1962b: 60), it occurred very rarely in the catchment area.
Figure 8.
Samples — 253, 307, 326, 327, 411, 449, 477, 512, 554.

A. exigua Grunow (cf. Hustedt 1927—1964, Teil **2**: 386, F. 832a, b).
Samples — 409, 412.

A. exigua var. *heterovalvata* Krasske (cf. Hustedt 1927 bis 1964, Teil **2**: 386, F. 832c—f).
Hustedt (1949A: 75) has reunited this variety with the typical forms, but in neither Cholnoky's researches nor in this present study have any transitional forms been observed linking the variety to the typical forms of the species. The specimens of var. *heterovalvata* from the catchment area agreed with Hustedt's description (Hustedt 1927—1964: 386) containing 28—32 transapical striae in 10 μ on the raphovalve and 20—24 straie on the areovalve. On these grounds and on the arguments set out by Cholnoky (1957a: 39) it was felt to be preferable to maintain var. *heterovalvata* as distinct from the typical forms.
This variety was observed in a large number of samples and was more common than the typical form. In South Africa it has been recorded from neutral to weakly alkaline waters, and according to Cholnoky (1960a: 14) is capable of tolerating small fluctuations of the pH value to the acid side.
Samples — 239, 306, 323, 326, 330, 340, 356, 477, 485, 486, 492, 553, 554.

A. lanceolata (Brébisson) Grunow (cf. Hustedt 1927 bis 1964, Teil **2**: 408, F. 863a—d).

In South Africa *A. lanceolata* has been reported from neutral waters with fluctuations of the pH to the acid side (CHOLNOKY 1960a: 16; 1962a: 6); this probably accounts for the scarcity of this species in the samples, as most of the rivers in this region had pH values above pH 8.0.
Samples — 239, 261, 266, 307, 316, 411, 454, 498.

A. lanceolata var. *elliptica* CLEVE (cf. HUSTEDT 1927 bis 1964, Teil **2**: 410, F. 863n, o.).
Samples — 356, 604, 433, 437, 486.

A. lanceolata var. *rostrata* (ÖSTRUP) HUSTEDT (1927 bis 1964, Teil **1**: 410, F. 863i—m).
In contrast with CHOLNOKY's observations in Natal (CHOLNOKY 1960a: 16) and in the Cape Province (CHOLNOKY 1962a: 6), this variety was far more common than the typical forms, and occurred over a wide area of the region under investigation.
Figures 9—11.

A. linearis (W. SMITH) GRUNOW (cf. HUSTEDT 1927 bis 1964, Teil **2**: 378, F. 821a, b).
This small *Achnanthes* species is closely related to and bears a strong similarity to *A. minutissima* KÜTZING. *A. linearis*, however, differs from the latter ecologically and by having a relatively broader valve and a more pronounced central area. Furthermore the transapical striae are coarser and clearly defined in A. linearis. In his report on the diatoms from the Sunda Islands HUSTEDT (1937—1939, Suppl. **15**: 192, T. 13, F. 41—46) described the new variety. *A. minutissima* var. *robusta*, commenting that „Die Form nähert sich in mancher Hinsicht der *Achnanthes linearis*, ist aber mit *A. minutissima* verbunden, während *A. linearis* in Gebiet nicht vorkommt". The var. robusta appears to be the same as *A. linearis*, and in the author's opinion should be regarded as a synonym of *A. linearis*.
While *A. linearis* has been reported from weakly acidic waters in South Africa (CHOLNOKY 1960a: 16; 1962a: 7; 1966b: 172), it was found commonly in the Klip and Wilge Rivers, whose waters are generally alkaline in character. In some samples *A. linearis* was present in relatively high numbers.

A. microcephala (KÜTZING) GRUNOW (cf. HUSTEDT 1927 bis 1964, Teil **2**: 376, F. 819).
The distribution of this species is limited to waters with a high percentage oxygen saturation, while its optimum development is found in such oxygen-rich waters having a neutral to slightly acid pH value. In the rivers under investigation such conditions were not often obtained with the result that the species was found in only a few samples.
Samples — 333, 338, 370, 403, 411, 456.

A. minutissima KÜTZING (cf. HUSTEDT 1927—1964, Teil **2**: 376, F. 820a—c).
On account of its autecology, *A. minutissima* is regarded as an indicator species of oxygen rich water. CHOLNOKY (1962b: 61) stated that *A. minutissima* reproduces best in oxygen rich, weakly alkaline water, and cannot tolerate a high osmotic pressure or a high concentration of organic nitrogenous materials. Consequently when this species occurs in great numbers it indicates water of good quality. *A. minutissima* is very wide spread in its distribution in South Africa, and was one of the most frequently occurring species in the Vaal Dam Catchment Area. At some sampling points it was the dominant diatom species in the association.

A. pinnata HUSTEDT (1937—1939, Suppl. **15**: 201).
Only one specimen was recorded and there is some doubt concerning its correct identification.
Sample — 412.

A. pseudohungarica CHOLNOKY-PFANNKUCHE (1966: 413, F. 1—16).
This species was first discovered in a culture prepared from a diatom sample collected from the Bloukrans River just outside Grahamstown. These examples found in the Transvaal agree in all respects with the smaller forms of CHOLNOKY-PFANNKUCHE's species. Two valves (Figs. 12, 13) have been drawn to illustrate this.
A. pseudohungarica was observed in one sample from the Klerkspruit River near Kestell in the Orange Free State, and composed 3.2% of the diatom association.
Figures 12, 13.
Sample — 362.

Amphipleura KÜTZING 1844.

A. pellucida KÜTZING (cf. HUSTEDT 1927—1964, Teil **2**: 724, F. 1095).
In most cases the valves of *A. pellucida* observed in this study fell within the dimensions given by HUSTEDT (l. c.), but occasionally specimens were observed which agreed with CHOLNOKY's smaller dimensions (CHOLNOKY 1957a: 41).
The species, although widespread in its distribution in the catchment area, was present as single specimens in most of the samples.

Amphora EHRENBERG 1840.

A. coffaeformis (AGARDH) KÜTZING (cf. HUSTEDT 1930: 345, F. 634).
CHOLNOKY (1957a: 42, 1960b 234; 1962a: 10; 1962b: 63) regarded this species as autochthonous in neutral to slightly alkaline waters having a low osmotic pressure. In the catchment area it occurred in many localities, but never in great numbers.

A. fontinalis HUSTEDT (1937—1939, Suppl. **15**: 414, T. 24, F. 4, 5).
This species, rare in South Africa, differed slightly from HUSTEDT's original description by having 20 striae in 10 μ instead of 24.
CHOLNOKY (1956: 57) reported this species as acidobiontic in the Tugela River area of Natal. No further comment on its autecology can be added here as only a single specimen was observed.
Figure 14.
Sample — 412.

A. ovalis Kützing (cf. Hustedt 1930: 342, F. 628).
Samples — 245, 312, 327, 342, 363, 454, 468, 489, 493.

A. ovalis var. *libyca* (Ehrenberg) Cleve (cf. Hustedt 1930: 342).
Transitional forms (Cholnoky 1962a: 10) linking the varietal and typical forms were not evident in this survey, and the variety has thus been retained.
The variety occurred as isolated examples in a number of samples.

A. ovalis var. *pediculus* (Kützing) Grunow (cf. Hustedt 1930: 343, F. 629).
Samples — 326, 337, 338, 339, 340, 363, 364, 378, 412, 432, 476, 497.

A. submontana Hustedt (1949 A: 112, T. 11, F. 4).
Examples of this species observed in the course of this study agreed with Hustedt's (l. c.) original description. However, in most cases the transapical striae were too fine to be visible unter the light microscope, and as a result of this probably number more than 40 in 10 μ. As with Cholnoky (1963c: 162) the transapical strae in the stauros were not seen.
As conditions in the catchment area do not suit the development of this species, it was found in small numbers, but covering a wide area.

A. thermalis Hustedt (1949a: 111, T. 11, F. 1—3).
The specimen seen here was a little smaller (17 μ long and 3.5 μ wide) than the dimensions given in the original diagnosis (length 18—35 μ, breadth about 5 μ). However, Hustedt described it from only one locality and cannot, therefore, have given the full range of variation. To the author's knowledge this is the first record of this species in South Africa.
Sample — 402.

A. veneta Kützing (cf. Hustedt 1930: 345, F. 631).
Sample Vaal 498 contained some exceptionally small specimens of *A. veneta*, being only 4 μ long. These small forms, however, intergraded with the more typical specimens of the species.
There appears to be some doubt with regard to the autecology of *A. veneta*. It seems clear that this species is closely connected to alkaline waters with very high pH values (Cholnoky 1958c: 316; 1960a: 26; 1966b: 174), but its tolerance to dissolved salts is in dispute. In most instances Cholnoky regarded this species as belonging to freshwater associations. However in his study on the ecology of the diatoms from Lake Chrissie (Cholnoky 1965: 67) he stated categorically „ihr Optimum findet sie aber in salzhaltigen Gewässern, und ihr Vorkommen in einer hohen Individuenzahl muß dementsprechend auch als Zeichen eines höheren osmotischen Druckes gedeutet werden". This statement was later refuted by Cholnoky himself in his book on the "Ecology of the Diatoms in Inland Waters" (Cholnoky 1968: 222), where he maintained that *A. veneta* is not a brackish water diatom, but an inhabitor of strongly alkaline water, which cannot tolerate variations in the osmotic pressure. The distribution of this species in the Vaal Dam Catchment Area tends to agree with Cholnoky's latter statement. The species was found fairly commonly all over the catchment area; and in samples Vaal 414 (54.6%) und Vaal 498 (25.3%) it was the dominant species.
Figure 15.

Anomoeoneis Pfitzer 1871.

A, brachysira (Brébisson) Cleve (cf. Hustedt 1927 bis 1964, Teil 2: 748, F. 1112e—h).
A. brachysira is a tropical-subtropical species occurring in waters with a low pH value (Cholnoky 1954b: 206; 1956: 57; 1962b: 64). It occurred in one sample from the Klip River at Memel.
Sample — 359.

A. exilis (Kützing) Cleve (cf. Hustedt 1927—1964, Teil 2: 751, F. 1114a—c).
As *A. exilis* has a pH optimum between pH 6.7 und 7.0, it occurred only as isolated specimens in a few samples from the alkaline waters of the catchment area.
Samples — 233, 309, 312, 317, 324, 342, 344, 347, 350, 418, 422, 441, 468.

A. spaherophora (Kützing) Pfitzer (cf. Hustedt 1927 bis 1964, Teil 2: 740, F. 1108a).
Samples — 239, 344, 408, 412, 415, 511.

Caloneis Cleve 1891.

C. bacillum (Grunow) Cleve (cf. Hustedt 1930: 236, F. 360).
The distinction between *C. bacillum* and *C. silicula* (Ehrenberg) Cleve is very difficult to define precisely, and indeed more careful examination of the two species may result in the uniting of the two species. Hustedt (1949a; 99) regarded the main distinction between *C. bacillum* and *C. silicula* to be the central area; *C. bacillum* having a large wide transapical band or fascia, while in *C. silicula* the band is either narrow or absent. This, however, appears to be a very doubtful distinction, particularly as Hustedt (1930: 236) described the central area of *C. bacillum* as „eine bis an den Schalenrand reichende Querbinde von wechselnder Breite". Amongst the many typical examples observed in the catchment area, an abnormal form having slightly constricted valve walls was seen (Fig. 16).

C. bacillum is a tropical-subtropical species found in neutral to weakly alkaline waters which are more or less oligotrophic (Cholnoky 1960a: 27; 1962b: 19). It was found to be widespread in the catchment area, particularly in the Vaal and Waterval Rivers. Figure 16.

C. bacillum var. *fontinalis* Grunow (cf. Hustedt 1937 bis 1939, Suppl. 15: 282, T. 15, F. 17—19).
This variety has previously been recorded from South Africa only in Natal (Cholnoky 1956: 58), and was observed in one sample from the Kalk River (Vaal 402) in this investigation.
Sample — 402.

C. bacillum var. *minima* CHOLNOKY (1954b: 206).
Only its much smaller dimensions distinguishes this variety from the typical forms of the species. CHOLNOKY (l. c.) has recorded it only from the type locality near Umtali in Rhodesia. It was observed in very few samples from the catchment area.
Figure 17.
Samples — 326, 327, 331, 362, 364, 411, 436, 451, 456.

C. Chasei CHOLNOKY (1954b: 206, F. 4, 5.)
The examples of *C. Chasei* from the Vaal Dam Catchment Area exhibited a series in which the number of transapical striae of the value ranged from about 36 to more than 40 in 10 μ. In the specimens from the upper reaches of the Wilge River (Vaal 328, 331, 333) the transapical striae were so fine that they were practically invisible (i. e. more than 40 in 10 μ). One such specimen has been illustrated (Fig. 18.)
In South Africa the species is widely distributed in weakly acid waters with a pH range of between 6 and 7 (CHOLNOKY 1960b: 237). Small numbers of this species were found in a few samples.
Figure 18.
Samples — 261, 301, 307, 328, 331, 333, 345, 358, 359, 370, 479, 485.

C. Clevei (LAGERSTEDT) CLEVE (cf. HUSTEDT 1930: 236, F. 359).
An unusually short form of the species (21 μ long) has been illustrated.
Found in neutral to weakly basic oligotrophic waters, this was one of the most commonly found *Caloneis* species in the Vaal Dam Catchment Area, although it never occurred abundantly in any one sample.
Figure 19.

C. Clevei var. *tugelae* CHOLNOKY (1962c: 317).
Samples — 401, 402, 404, 405, 406, 408.

C. hyalina HUSTEDT (1937—1939, Suppl. **15**: 281, T. 15, F. 8—10).
The specimen, illustrated in Figure 24, did not entirely agree with the original description given by HUSTEDT (l. c.). However, it corresponded more closely with this species than with any other *Caloneis*. It was more lanceolate than the typical forms, and was more acutely rounded at the poles (cf. HUSTEDT l. c. T. 15, F. 10). The central pores were widely spaced and agreed with the diagnosis. The transapical striae of this example were not visible and probably number more than 40 in 10 μ, while HUSTEDT's specimens varied between 36 and 38 in 10μ. The differences shown by this specimen do not, however, warrant the description of a new taxon.
Figure. 24.
Sample — 307.

C. incognita HUSTEDT (1910: 373, T. 3, F. 7).
In his studies on African diatoms CHOLNOKY has been able to establish a wider range of variation for this species than was originally cited. Many of his examples reached a lower limit of 22 μ long, and 8.5 μ wide (CHOLNOKY 1962b: 65). One of the smaller examples found in the catchment area has been illustrated in Figure 25.
This species was found in only four samples from the Waterval, Kaffirspruit and Tier Rivers.
Figure 25.
Samples — 245, 401, 419, 491.

C. Lagerstedtii CHOLNOKY (1957a: 43, F. 17—20).
In the course of this survey some abnormal forms of the species have been observed. Figures 20 and 21 illustrated two small examples, the shortest being 12.5 μ long. Two further abnormal valves were illustrated, Figures 22 and 23, having triundulate valve walls. There is, however, no evidence that the latter constitute a new form of the species.
The autecology of the species is not clearly defined. It occurred fairly commonly in the catchment area, but was never abundant in any of the samples.
Figures 20—23.

C. Schumanniana (GRUNOW) CLEVE var. *trinodis* (LEWIS) CLEVE (cf. HUSTEDT 1930: 269, F. 369 under *C. Schumanniana* var. *biconstricta*).
This variety is not common in South Africa and has been recorded only twice by CHOLNOKY (1958a: 249; 1966a: 11). In the catchment area a few isolated examples of the variety were seen in a number of samples, mainly from the Vaal River. The typical forms of *Caloneis Schumanniana* (GRUNOW) CLEVE were not observed in this study.

C. silicula (EHRENBERG) CLEVE (cf. HUSTEDT 1930: 236, F. 362).
The lines of demarcation between many species in the genus Caloneis and between varieties within a species are extremely difficult to determine. It is possible that *C. silicula* and *C. bacillum* (see above) from part of the same variational range.

C. silicula, whose autecology is unknown, occurred fairly commonly in the catchment area, but never in abundance.

Cocconeis EHRENBERG 1838.

C. microscopica CHOLNOKY (1959: 17, F. 105, 106).
The specimens of this rare species were slightly smaller than CHOLNOKY's original dimensions, and the original diagnosis should be supplemented by the measurements observed in these samples. The new dimensions are therefore: — length 6—9 μ, breadth 3—4 μ and transapical striae of both valves 28—39 in 10 μ.
The species was recorded from one sample near the source of the Vaal River.
Sample — 486.

C. placentula EHRENBERG (cf. HUSTEDT 1927—1964, Teil **2**: 347, F. 802a, b).
In this species, as in many others, there is no clear cut division between the typical and the varietal forms. There is more often than not a gradation between the two, and, if not particularly clear, it is left to the taxo-

nomist to make a decision. CHOLNOKY (1963c: 164) reported transitional forms linking the variety var. *euglypta* to the typical forms of the species, and remarked that this made the separation of this variety rather doubtful. The examples from the catchment area emphasised in many cases the doubtful nature of this separation.
Typical forms of *C. placentula* were found in a number of localities in the catchment area, but never in great quantities.

C. placentula var. *euglypta* (EHRENBERG) CLEVE (cf. HUSTEDT 1927—1964, Teil 2: 349, F. 802c).
The var. *euglypta* occurred more frequently in the catchment area than the typical forms of the species, and in a few samples it was relatively abundant in its occurrence.

C. placentula var. *klinoraphis* GEITLER (cf. HUSTEDT 1927 bis 1964, Teil 2: 348, F. 803).
This appears to be the first record of this variety for South Africa, being observed in four samples from the catchment area.
Samples — 337, 375, 410, 449.

C. placentula var. *lineata* (EHRENBERG) CLEVE (cf. HUSTEDT 1927—1964, Teil 2: 348, F. 802d).
GIFFEN (1966: 129) recorded this variety in one sample from the Hog's Back region in the Eastern Cape Province. It was found in a sample from the Vaal River at Station 5 (Vaal 319), and in another from the Wilge River at Station 13 (Vaal 231).
Samples — 231, 319.

C. scutellum EHRENBERG (cf. HUSTEDT 1927—1964, Teil 2: 337, F. 790).
The species is rare in South African waters since it is marine and only occurs in estuaries or river mouths. It was found in one sample and must be regarded as displaced and definitley not autochthonous.
Sample — 405.

Coscinodiscus EHRENBERG 1838

C. excentricus EHRENBERG (cf. HUSTEDT 1927—1964 Teil 1: 388, F. 201).
This is also a marine species recorded in South Africa from marine and brackish habitats. It must be regarded as outside its ecological niche, and not autochthonous for the area.

C. lacustris GRUNOW (cf. HUSTEDT 1927—1964, Teil 1: 432, F. 235a, b).
Although this diatom species is mainly a brackish water form, it has been found to occur in freshwater (HUSTEDT l. c.). In South Africa it has been reported from the mouths of rivers and occasionally from freshwater. In the Vaal Dam Catchment Area it was found in one sample from the Waterval River, where it cannot be regarded as autochthonous.

Cytlotella KÜTZING 1834

C. comensis GRUNOW (cf. HUSTEDT 1927—1964, Teil 1: 353, F. 182).
The specimens placed in this species were in general smaller than the dimensions given by HUSTEDT (l. c.), but there was a gradual transition to the typical form of the species. The minimum size recorded was 4.5 μ in diameter. The striae were generally greater in number, being up to 20 in 10 μ. In all the specimens observed here the structure of the central area and the length of the striae were very variable.
Its distribution in the catchment area was quite widespread, occurring commonly in the Waterval River, where it was sometimes abundant. This is the first record of this species in South Africa.
Figure 26.

C. Kuetzingiana THWAITES (cf. HUSTEDT 1927—1964, Teil 1: 338, F. 171a).
Sample — 403.

C. Meneghiniana KÜTZING (cf. HUSTEDT 1927—1964, Teil 1: 341, F. 174).

C. Meneghiniana has been reported from many localities in South Africa, and is regarded as autochthonous in relatively eutrophic and alkaline water. In the region under investigation it was found at relatively few localities and never in great numbers.

C. pseudostelligera HUSTEDT (1939: 581, F. 1, 2).
The distinguishing character differentiating this species from *C. stelligera* CLEVE et GRUNOW (cf. HUSTEDT 1927 bis 1964, Teil 1: 339) is the presence of marginal spines in *C. pseudostelligera*. FOGED (1966: 50, Pl. 1, F. 3) presumably misunderstood this difference since he illustrated a specimen under the name *C. stelligera*, containing 18 striae and 10 marginal spines in 10 μ. FOGED's specimen by virtue of the spines and its dimensions must be assigned to HUSTEDT's species, *C. pseudostelligera*. In the Vaal Dam Catchment Area only one damaged specimen was noted (Fig. 28). This specimen had a slightly denser arrangement of the striae (22 in 10 μ) than was given by HUSTEDT in his original description; this does not, however, warrant the description of this specimen as a new taxon. Figure 27 illustrates a valve whose identity is somewhat doubtful. It was originally thought to be a possible new species. However an article by BELCHER SWALE and HERON (1966: 335) illustrated some valves (*C. Woltereckii* type) which could be equated with the specimen illustrated in Figure 27. In studying the morphological variations of a clonal culture of *C. pseudostelligera*, BELCHER et al. observed a great variability in the morphology of the valve. *C. pseudostelligera* forms were present when the silica content of the cultures was present in sufficient quantities, but, when the silica content was low and there was a deficiency, cells of another form were found; these they identified as *C. Woltereckii*, noting them to be weakly silicified forms. Since both forms were derived from the same clonal culture BELCHER et al. regarded them as extreme morphological forms of the same species, which, by priority, should be called *C. pseudostelligera* HUSTEDT. On these grounds it was felt that, owing to the similarity of the specime

illustrated in Fig. 27 to the weakly silicified forms of *C. pseudostelligera*, this specimen should be included with this species.
These two valves were the only two representatives of this species observed in the catchment area, and constitute the first record of *C. pseudostelligera* for South Africa.
Figure 27, 28.
Samples — 321, 445.

C. stelligera CLEVE et GRUNOW (cf. HUSTEDT 1927—1964, Teil 1: 339, F. 172).
Localities for favourable growth of planktonic diatoms have not often been sampled in South Africa. Consequently records of this species form South Africa are rare. The record of *C. stelligera* made by FOGED for Ghana has already been shown to be erroneous in the above paragraphs. A single specimen of this species was discovered in a sample from the Vaal River near its source.
Sample — 486.

C. stelligeroides HUSTEDT (1945: 899, T. 42, F. 68, 69).
As far as is known this is the first record of this species for South Africa. Two specimens, agreeing with HUSTEDT's original description of the species, have been illustrated in figures 29, 30. The specimens were recorded from the Vaal River at Station 5 A, and from the Skulpspruit near Amersfoort.
Figures 29, 30.
Sample — 322, 465.

Cylindrotheca RABENHORST 1859.

C. gracilis (BRÉBISSON) W. SMITH (cf. HUSTEDT 1930: 393, F. 746).
CHOLNOKY (1966c: 164) maintained that the relative paucity of records for this species is due to its extremely weak silification of the cell walls, making it difficult to observe. The only previous record of this species in South Africa is from a gold mine dam in the Orange Free State. It was found in two samples from the catchment area, one from Station 3 on the Vaal River, and the other from the Vrede Stream.
Samples — 312, 429.

Cymatopleura W. SMITH 1851.

C. solea (BRÉBISSON) W. SMITH (cf. HUSTEDT 1930: 425, F. 823a).

C. solea was one of the more commonly occurring diatom species in the catchment area, and was abundant in a number of samples.

Cymbella AGARDH 1830.

C. aequalis W. SMITH (cf. HUSTEDT 1955a: 52, F. 17—21).
The species occurred in a number of samples from the Vaal and Klip Rivers, but was never present in large numbers.

C. amphicephala NAEGELI (cf. HUSTEDT 1930: 355, F. 651).
The specimens of *C. amphicephala* observed in these samples support CHOLNOKY's findings that there are, together with the normal forms, some smaller examples. The valves here generally measured between 20 and 24 μ long, and 6—7 μ broad.
The species is found in neutral to weakly alkaline water (CHOLNOKY 1962b: 67), and has a pH optimum of about 7.2 (CHOLNOKY: personal communication). Its distribution in the catchment area was very wide, abundant in a number of samples and in a few the dominant or co-dominant diatom species.

C. aspera (EHRENBERG) HÉRIBAUD (cf. HUSTEDT 1930: 365, F. 680).
The species is of rare occurrence in South Africa, and in the catchment area was recorded in small numbers ata few localities.
Samples — 266, 306, 328, 330, 331, 343, 344, 358, 437, 438, 441, 456, 477, 485, 486.

C. bengalensis GRUNOW (A. S. Atl. T. 9, F. 12, 13; T. 71, F. 79; T. 375, F. 2, 3 and 6).
Samples — 350, 353, 422, 491, 492, 495.

C. cistula (HEMPRICH) KIRCHNER (cf. HUSTEDT 1930: 363, F. 676a).
According to DE TONI (1891: 365) Dr. O. KIRCHNER was the first to use the combination *Cymbella cistula*; this preceded GRUNOW's use of the same combination by two years. KIRCHNER should therefore be cited as the correct co-author of this species.

C. cistula is widespread in neutral to weakly alkaline waters of South Africa (CHOLNOKY 1960a: 32; 1962b: 67).
Although its percentage occurrence in the samples was low, it was one of the more commonly occurring *Cymbella* species of the catchment area.

C. delicatula KÜTZING (cf. HUSTEDT 1930: 352, F. 642).
Samples — 427, 441, 465, 491, 495, 496.

C. gracilis (RABENHORST) CLEVE (cf. HUSTEDT 1930: 359, F. 663).
No evidence for an isolated stigma in *C. gracilis* was found in the specimens observed, and this lends support to CHOLNOKY's claim that *C. gracilis* and *C. turgida* var. *pseudogracilis* CHOLNOKY (1958b: 112, F. 49, 50) are two taxonomic entities.
Although HUSTEDT (l. c.) claimed that *C. gracilis* is found in a pH range of 4—8.5, CHOLNOKY (1960b: 238) stated that it inhabits relatively acid water. In the catchment area *C. gracilis* was recorded from three samples collected from the acid waters of Station 1, and once from the Holspruit River in the Orange Free State. This observation supported the more limited range of tolerance to pH put forward by CHOLNOKY.
Samples — 253, 301, 370, 479.

C. Kappii Cholnoky (1956: 61, F. 17—20).

C. Kappii has been found in subtropical regions in oligotrophic, neutral to alkaline waters of South Africa (Cholnoky 1960a: 33; 1962b: 68). In the Vaal Dam Catchment Area it is one of the most common *Cymbella* species, occurring most frequently in association with *C. amphicephala*, *C. microcephala* and *C. ventricosa* in high relative densities.

C. Kolbei Hustedt (1949b: 46, F. 20—26).
This species appears to be tropical-subtropical in distribution, and is regarded by Cholnoky (1962b: 68) as a characteristic species of oligotrophic, alkaline water. In the catchment area it was found in low numbers in relatively few samples.

C. microcephala Grunow (cf. Hustedt 1930: 351, F. 637).

C. microcephala appears to be limited to weakly alkaline to neutral waters, fluctuating sometimes towards the acid side. Its pH optimum, according to Cholnoky (personal communication), lies around pH 7.2. It is also found in water having a high percentage oxygen saturation. It is not surprising, therefore, that it often occurred in great numbers in well oxygenated alkaline waters of the catchment area. In some samples it was the dominant species, while in others it was a co-dominant species in association with *C. amphicephala*, *C. Kappi* and *C. ventricosa*. This was one of the most commonly occurring diatom species in the catchment area.

C. naviculiformis Auerswald (cf. Hustedt 1930: 356, F. 653).
It is not a common species in the catchment area, occurring mainly in the Vaal River.

C. Oliffii Cholnoky (1956: 63, F. 23—27).
On closer examination some specimens described as *C. aequaloides* Archibald (1966a: 254) were found to be *C. Oliffii* (Fig. 31), described by Cholnoky (l. c.) some years previously from Natal. Consequently *C. aequaloides* must be reduced to a synonym of *C. Oliffii*.
Fig. 31.
Samples — 403, 408.

C. perpusilla A. Cleve-Euler (cf. Hustedt 1930: 361, F. 666).

C. perpusilla (Fig. 32) was not found to any great extent in this study, and was recorded mainly from the Waterval and Vaal Rivers.
Fig. 32.

C. raytonensis Cholnoky (1955b: 162, F. 19—21).
The species was observed in one sample from Station 1 on the Vaal River, where the water was always acidic.
Sample — 301.

C. Schweickerdtii Cholnoky (1953a: 141, F. 6—11).
Samples — 325, 345, 465, 495.

C. turgida Gregory (cf. Hustedt 1930: 358, F. 660).
There are few references concerning the autecology of this species. Hustedt (1937—1939, Suppl. 15: 427) claimed that its pH tolerance range was 6.5 to over 8.0, and stated that „die Hauptentwicklung liegt jedenfalls bei einem pH um 8". Cholnoky (1960a: 36) mentioned only that he had found the species to be widespread and often abundant in the neutral waters of Natal. In the generally alkaline waters of the catchment area *C. turgida* was present in a relatively small number of samples from widespread localities.

C. turgida var. *pseudogracilis* Cholnoky (1958b: 112, F. 49, 50).
The variety apparrently finds its optimum development in acid waters and was consequently recorded in very small numbers from one locality on the Waterval River, and at Station 12 on the Wilge River.
Samples — 334, 554.

C. ventricosa Agardh (cf. Hustedt 1930: 359, F. 661).
In South Africa the species has been reported from oligotrophic, neutral to weakly alkaline waters, in which it finds its optimum (Cholnoky 1960a: 36; 1962a: 19; 1962b: 70; 1962c: 319). This probably accounts for its occurence in a great many samples from the catchment area, where it sometimes occured in the samples with high relative densities. It was one of the most commonly occurring diatoms in the region.

Diploneis Ehrenberg 1844.

D. marginestriata Hustedt (1927—1964, Teil **2**: 677, F. 1068b).
A single specimen of this species was observed in the catchment area. It differed from Hustedt's description (l. c.) only in its breadth, being relatively narrower 7 μ wide). In all other respects it agreed with Hustedt's diagnosis. This is the first record of this species for South Africa.
This specimen was collected from the Grootspruit River, a tributary of the Waterval River.
Fig. 33.
Sample — 441.

D. ovalis (Hilse) Cleve (cf. Hustedt 1927—1964, Teil **2**: 671, F. 1065a—e).
In the Vaal Dam Catchment Area this species was found in small numbers in relatively few samples, mainly from the Waterval and Vaal Rivers.

D. pseudovalis Hustedt (1927—1964, Teil **2**: 668, F. 1063c).
This species can very easily be mistaken for *D. subovalis*, being superficially very similar. The difference can only be realised on closer examination, when it can be seen that the two rows of poroids between the costae are arranged opposite each other and not diagonally ("quincunx") as in *D. subovalis*. For this reason it is doubtful whether some of the specimens, observed in the early part of this study, were in fact *D. pseudovalis*.

D. pseudovalis is normally regarded as a brackish water species, and has most often been recorded from coastal rivers in South Africa. It was recorded from Station 15 and 16 on the Kalk River, which is slightly mineralized from the Springfontein Colliery. It was also found at a few other localities in the catchment area.
Samples — 401, 402, 406, 410, 447.

D. Smithii (BRÉBISSON) CLEVE var. *pumila* (GRUNOW) HUSTEDT (1927—1964, Teil **2**: 650, F. 1052d, e).
Samples — 419, 477, 511, 512.

D. subovalis CLEVE (cf. HUSTEDT 1927—1964, Teil **2**: 667, F. 1063a, b).

D. subovalis is the most commonly occurring member of the genus *Diploneis* in South Africa. In the catchment area it was frequently recorded from the samples, sometimes in high numbers, and was far more common than any other species of the genus *Diploneis*.

Epithemia BRÉBISSON 1838.

E. sorex KÜTZING (cf. HUSTEDT 1930: 388, F. 736).

There is little information on the autecology of this species. In the catchment area it was recorded from a small number of samples. In two of these it occurred in relatively high numbers (9.9% in Vaal 405, and 4.6% in Vaal 411). Both these localities had water with high pH values (pH 8.7), indicating some preference of *E. sorex* for highly alkaline water.
Samples — 323, 326, 365, 402, 405, 411, 412, 413, 420.

E. zebra (EHRENBERG) KÜTZING (cf. HUSTEDT 1930: 384, F. 729).
Samples — 301, 306, 323, 326, 327, 405, 406, 411, 415, 420, 441, 477, 552.

Eunotia EHRENBERG 1837.

E. diodon EHRENBERG (cf. HUSTEDT 1927—1964, Teil **2**: 276, F. 742).
Sample — 479.

E. exigua (BRÉBISSON) RABENHORST (cf. HUSTEDT 1927—1964, Teil **2**: 285, F. 751a—v).
CHOLNOKY (1960b: 241; 1962a: 23; 1962b: 71) has reported this species from oligotrophic, acidic waters with a pH ranging between 6.0 and 6.5 (its optimum lying below 6.0). Of the five samples from which it was recorded, three (Vaal 301, 370 and 479) were collected at the headwaters of the Vaal River at Station 1, where the pH was measured as fluctuating between 6.0 and 6.8. In two of these samples the relative densities of this species was 0.7% and 0.8%. The remaining two samples were collected at two localities on the Wilge River, whose pH values were not measured.
Fig. 34.
Samples — 301, 327, 331, 370, 479.

E. flexuosa (BRÉBISSON) KÜTZING (cf. HUSTEDT 1927—1964, Teil **2**: 312, F. 778).
Most *Eunotia* species are acidophilic and this species is no exception. In the Vaal Dam Catchment Area it was found only at the headwaters of the Vaal River, where the pH was found to be pH 6.5. One or two specimens were seen in each sample.
Samples — 301, 370.

E. garusica CHOLNOKY (1952: 124, F. 153, 154).
E. garusica is found in relatively acid waters in South Africa and is fairly widespread throughout the country. In the catchment area it has been found only at the headwaters of the Vaal River and in one sample from Lake Chrissie, which lies just outside the catchment area near the source of the Vaal River.
Samples — 301, 485.

E. gracilis (EHRENBERG) RABENHORST (cf. HUSTEDT 1927—1964, Teil **2**: 305, F. 771).
This species has been collected from relatively few localities in South Africa. CHOLNOKY has reported it from the Transvaal (CHOLNOKY 1955b: 166; 1957b: 348) and from Natal (1956: 66). More recently GIFFEN (1966: 132) has recorded it from the Hog's Back Region of the Eastern Cape Province. In the catchment area a single specimen was found in the Kleinvaal River, a tributary of the Vaal River.
Sample — 464.

E. lunaris (EHRENBERG) GRUNOW (cf. HUSTEDT 1927—1964, Teil **2**: 302, F. 769a, b, d, e).
CHOLNOKY (1962b: 71) maintained that this species is found in acidic and oligotrophic waters, and that its optimum pH lies around 6.0. The species occurred in the catchment area at only three localities, Station 1 on the Vaal River, Station 17 on the Waterval River, and from a sample collected at Lake Chrissie.
Samples — 301, 340, 485.

E. pectinalis (KÜTZING) RABENHORST (cf. HUSTEDT 1927—1964, Teil **2**: 296, F. 763a).
There is some doubt concerning the type specimen of *Eunotia pectinalis*. Some authors regard *Himantidium pectinale* KÜTZING as the type, while others tentatively suggest the controversial *Conferva pectinalis*. Both HUSTEDT (l. c.) and DE TONI (1891: 793) quoted *C. pectinalis* DILLWYN as a dubious synonym of *E. pectinalis*. At the same time HUSTEDT (l. c.: 144) cited *C. pectinalis* O. F. MÜLLER as a synonym of *Fragilaria capucina* DESMAZIÈRES. The question to be resolved, therefore, is whether *C. pectinalis* DILLWYN and *C. pectinalis* O. F. MÜLLER are one and the same species. According to PATRICK and REIMER (966: 205), DILLWYN attributed the description of *C. pectinalis* to O. F. MÜLLER. AGARDH (1824: 7) apparently regarded O. F. MÜLLER as the author of *C. pectinalis*, quoting DILLWYN's later record of the species. Thus it appears that *C. pectinalis* DILLWYN and *C. pectinalis* O. F. MÜLLER refer to the same species. If this is correct, a comparison of the synonymies of AGARDH (l. c.), DE TONI (l. c.: 688) and HUSTEDT (l. c.: 144) show that *C. pectinalis* O. F. MÜLLER is synonymous with *F. capucina* and is

unrelated to *E. pectinalis.* According to Cholnoky (personal communication) the specific epithet is derived from *Himantidium pectinale* Kützing, and Kützing should therefore be cited as author of the basionym with Rabenhorst. This latter concept has been accepted at the present time, and *H. pectinale* is regarded as the type.

The pH optimum of this species lies a little higher than most other *Eunotia* species, about pH 6.0—6.5 (Cholnoky 1960b: 242; 1962a: 331; 1966a: 18; 1966b: 182). Furthermore, according to Cholnoky, the species will not reproduce at pH values above 6.5—6.6, and will die when the pH is more than 7.0. The distribution of this species in the catchment area is limited to the Vaal River, where it occurred in the acid waters of Station 1, and in one sample from lower down the river.
Samples — 301, 370, 477.

E. pectinalis var. *minor* (Kützing) Rabenhorst (cf. Hustedt 1927—1964, Teil **2**: 298, F. 763d—f).
This variety, like the typical forms, is acidophilic and as a result is seldom seen in the catchment area, as the conditions found in this region do not suit the growth of this species.
Samples — 350, 370, 485.

E. polydentula Brun (cf. Hustedt 1927—1964, Teil **2**: 292, F. 759a, b).
This species (Fig. 35), like most others of the genus *Eunotia*, is stenotypically acidophilic (Cholnoky 1954c: 277) and it has been found in tropical — subtropical acidic and oligotrophic waters (Cholnoky 1960a: 41). The species appears to thrive when the pH of the water remains around pH 6.0. Its occurrence in the catchment area was extremely rare, one specimen being recorded at Station 11 at Harrismith.
Fig. 35.
Sample — 331.

E. praerupta Ehrenberg (cf. Hustedt 1927—1964, Teil **2**: 280, F. 747a—e).
This species has been recorded from many localities in Rhodesia and South Africa, mainly from the Transvaal and Natal. It was recorded from one sample from Lake Chrissie, just outside the catchment area.
Sample — 485.

E. pseudoveneris Hustedt (1942: 29, F. 24—29).
As the rivers in the catchment area are generally alkaline, with very few localities having acid water, the distribution of the *Eunotia* species is very limited.

E. pseudoveneris was observed as single records in three samples, one from the headwaters region of the Wilge River, one from the headwaters region of the Klip River, and the other from Lake Chrissie.
Samples — 328, 437, 485.

E. rhomboidea Hustedt (1946—1950: 435, T. 36, F. 34—41).
This small species (Fig. 36) has been found in many localities in South Africa, although it has not always been recorded under the same name. Cholnoky himself described this species three times, once as a completely new species, *E. raytonensis* (Cholnoky 1955b: 169) and twice as varieties of *E. tenella* Hustedt, var. *densestriata* (Cholnoky l. c.) and var. *capensis* (Cholnoky 1959: 106). These are now regarded as synonyms of *E. rhomboidea* Hustedt.

E. rhomboidea is found in oligotrophic, acidic waters and particularly in the acid waters on Table Mountain Sandstone (Cholnoky 1962b: 72). It was recorded in the catchment area only from the acid waters of Station 1.
Fig. 36.
Sample — 301.

E. Schweickerdtii Cholnoky (1954c: 278, F. 46, 47).
To the author's knowledge this is the first record of this species since Chonoky originally described it. In structure this specimen agreed with the description, but differed in its dimensions. Its length was 95 μ and its breadth 8 μ. These measurements increase the range of variation for this species. The transapical striae (16 in 10 μ) were also finer than the original measurement.
Sample — 370.

E. similis Hustedt (1937—1939, Suppl. **15**: 165, T. 12 F. 5—8).
Fig. 37.
Sample — 328.

E. subaequalis Hustedt (1937—1939, Suppl. **15**: 170 T. 12, F. 1—4).
Samples — 464, 485.

E. tenella (Grunow) Hustedt (1927—1964, Teil **2** 284, F. 749).
Samples — 301, 358.

Fragilaria Lyngbye 1817.

F. brevistriata Grunow (cf. Hustedt 1927—1964, Teil **2** 168, F. 676a—e).
It would appear that the complete range of variatio of this species has yet to be fully defined, sinc Cholnoky makes numerous references to abnorm forms. The only example of the species seen in th study was smaller than the dimensions given b Hustedt (8 μ long), and in this respect resemble similar short forms recorded from Lake Sibay (Archibald 1966b: 486).
It was recorded from two localities in the catchmen area, and once from Lake Chrissie.
Samples — 307, 431, 485.

F. brevistriata var. *inflata* Pantocsek (cf. Hustedt 1927—1964, Teil **2**: 169, F. 676h).
Sample — 436.

F. construens (Ehrenberg) Grunow (cf. Hustedt 1927—1964, Teil **2**: 156, F. 670a—c).

F. construens apparently thrives in water having a high percentage oxygen saturation, and survives in waters with a weak or relatively high pH value, but it cannot tolerate dissolved salts in large concentrations. In the catchment area it was scarce in occurrence.
Samples — 306, 307, 360, 406, 485.

F. construens var. *subsalina* HUSTEDT (1927—1964, Teil **2**: 159, F. 670p—s).
Sample — 322.

F. familiaris (KÜTZING) HUSTEDT (1957: 229).
The distribution of this species in South Africa is fairly widespread in neutral to weakly alkaline water (CHOLNOKY 1962b: 73: 1962c: 321). It was one of the most commonly occurring species of the genus *Fragilaria* in the catchment area, being particularly common in the Vaal River and its tributaries, where it occasionally appeared in high numbers.

F. fonticola HUSTEDT (1937—1939, Suppl. **15**: 151, T. 10, F. 61, 62).
In Natal CHOLNOKY (1960a: 43) found individuals of this species having up to 20 striae in 10 μ and measuring 4 μ in width. Thus a series can be drawn providing a link between the typical forms and the var. *angusta* HUSTEDT (l. c.). The distinction between the two forms therefore becomes pointless and the two have been united.
It was not common in the catchment area, being recorded from five samples.
Samples — 339, 377, 378, 410, 412.

F. fragilarioides (GRUNOW) CHOLNOKY (1963c: 168).
Sample — 340.

F. pinnata EHRENBERG (cf. HUSTEDT 1927—1964, Teil **2**: 160, F. 671a—i).
Samples — 239, 306, 307, 409, 437, 441, 485, 486.

F. pinnata var. *lancettula* (SCHUMANN) HUSTEDT (1927—1964, Teil **2**: 161, F. 671m—o).
Samples — 261, 486.

F. vaucheriae (KÜTZING) BOYE PETERSEN (1938: 167, F. 1c—g).
The conclusions of BOYE PETERSEN (l. c.) with respect to the systematics of the two species *Synedra vaucheriae* KÜTZING and *Fragilaria intermedia* have been adopted in this study, i. e. that these two species are in fact the same and, according to the rules of priority, should be called *Fragilaria vaucheriae* (KÜTZING) BOYE PETERSEN. In sample Vaal 412 some abnormally short forms of the species were observed (Figs. 38, 39); these specimens were only 7 μ long and intergraded with the more typical examples of the species.
The autecology of this species indicates that it has a preference for neutral to relatively alkaline waters, having a good supply of dissolved oxygen. Conditions in the Vaal Dam Catchment Area often fulfilled these requirements with the result that this species was widely distributed, sometimes occurring in very high numbers.
Figs. 38, 39.

F. virescens RALFS (cf. HUSTEDT 1927—1964, Teil **2**: 162, F. 672 A. a—b).
Samples — 410, 485.

Frustulia GRUNOW 1865.

F. rhomboides (EHRENBERG) DE TONI (cf. HUSTEDT 1927—1964, Teil **2**: 728, F. 1098a).
HUSTEDT described this species as being an "indifferent" form, thriving in a pH range of 5.5 to 8.2 (HUSTEDT 1937—1939, Suppl. **15**: 215). CHOLNOKY (1962b: 74; 1966b: 184), on the other hand, has found that in South Africa this species is limited to waters with a much narrower pH range in the region of pH 6.0. The three samples, from which this species was recorded in the catchment area, were collected from the acid waters of Station 1, thus appearing to support CHOLNOKY's observations.
Samples — 301, 370, 479.

F. rhomboides var. *saxonica* (RABENHORST) DE TONI (cf. HUSTEDT 1927—1964, Teil **2**: 729, F. 1099a).
No intermediate stages between the variety and the typical forms were observed in the catchment area, and thus the retention of the distinction between the species and its variety was preferred.
The autecology of the variety is similar to that of the species. In the catchment area the variety was recorded from a greater number of samples than the typical forms. These samples were collected from the upper reaches of the Vaal, Kleinvaal, and Wilge Rivers and some of their tributaries, where in some cases the waters were acid in character.

F. subvulgaris CHOLNOKY (1959: 27, F. 160).
F. subvulgaris was of rare occurrence in the Vaal Dam Catchment Area, being found mainly in the Waterval River. One of the examples was illustrated in Fig. 40. For further comments on this species see the note on *F. tugelae* CHOLNOKY.
Fig. 40.
Samples — 321, 324, 406, 410, 432, 477, 485, 497.

F. tugelae CHOLNOKY (1956: 71, F. 69).
GIFFEN (1966: 135) found that specimens from the Hog's Back Region showed a wider morphological range than was previously described. The range covered an intergrading series from the typical forms with constricted side walls to GIFFEN's forms with parallel side walls. This same range of form (Figs. 41—43) was observed in the catchment area. In an earlier publication on the diatoms from the Vaal Dam Catchment Area (ARCHIBALD 1966a) one of the straight sided forms of *F. tugelae* was erroneously assigned to and illustrated as *F. subvulgaris* CHOLNOKY.
This species was uncommon in the catchment area, and was found in a number of samples from the upper reaches of the Vaal, Klip and Wilge Rivers.
Figs. 41—43.
Samples — 327, 328, 330, 434, 464, 485.

F. vulgaris (THWAITES) DE TONI (cf. HUSTEDT 1927—1964, Teil 2: 730, F. 1100a).
Samples — 321, 325, 337, 339, 375, 378, 405, 406, 408, 410, 411, 413, 415, 498.

F. vulgaris var. *angusta* CHOLNOKY (1954b: 214, F. 61).
This variety occurred far more commonly than the typical forms of the species. CHOLNOKY has reported it many times from neutral to weakly alkaline waters of South Africa. These conditions were common in the region, resulting in a widespread distribution in the catchment area. The paucity of records from the Waterval River might be due to some confusion with the typical forms in the early part of this survey.

F. Weinholdii HUSTEDT (1927—1964, Teil 2: 731, 1101).
Three specimens of this extremely rare species (c. f. CHOLNOKY 1960a: 46) were recorded from Station 9 and 10 on the Wilge River, and once from Station 24 on the Klip River. One specimen (Fig. 44) was slightly shorter (36 μ long) than HUSTEDT's lower limit of 40 μ.
Fig. 44.
Samples — 327, 330, 437.

Gomphonema AGARDH 1824.

G. angustissimum HUSTEDT var. *africanum* CHOLNOKY (1959: 28, F. 161).
Due to its extremely long narrow valves, and enlarged punctae at the ends of the striae near the raphe, this variety was identified without any difficulty.
In the catchment area a single example was recorded from Station 1 on the Vaal River.
Sample — 370.

G. Clevei FRICKE (cf. HUSTEDT 1937—1939, Suppl. **15**: 441, T. 27, F. 15—18).
G. Clevei is characteristic of neutral to weakly alkaline waters, in which it shows a great variability (CHOLNOKY 1954c: 280; 1960b: 246; 1962b: 75). As the environmental conditions over a wide area of the region were suitable, it was one of the most commonly occurring species of the genus in the catchment area.

G. constrictum EHRENBERG (cf. HUSTEDT 1930: 377, F. 714).
This species occurred in a number of samples, but in none was it ever abundant.

G. constrictum var. *capitatum* (EHRENBERG) CLEVE (cf. HUSTEDT 1930: 377, F. 715).
This variety may provide the intermediate forms between the typical forms of the species and the var. *Gautierii* (VAN HEURCK) CHOLNOKY (CHOLNOKY 1965: 69), but no conclusive evidence of this was observed in the specimens from the catchment area.
The variety was recorded from the Sand River at Station 8, and from the Wilge River near Frankfort.
Samples — 233, 456.

G. constrictum var. *Gautierii* (VAN HEURCK) CHOLNOKY (1957b: 350, F. 43, 44).
Samples — 301, 327, 335, 437, 486.

G. dichotomum KÜTZING emend. ARCHIBALD (1966a: 255, F. 4).
Its distribution in the catchment area was widespread, and was recorded from relatively large numbers of samples.
Fig. 45.

G. gracile EHRENBERG (cf. HUSTEDT 1930; 376, F. 702).
An unusually short and broad form of this species has been illustrated in Fig. 46.
In South Africa CHOLNOKY (1962b: 75) has reported this species from oligotrophic, neutral waters, having fluctuations of the pH value to the acid side. Its distribution in the catchment area appeared to be quite widespread, although, never occurring in great abundance.
Fig. 46.

G. gracile f. *turris* (EHRENBERG e. p.) HUSTEDT (1937—1939, Suppl. **15**: 439).
Samples — 306, 338.

G. javanicum HUSTEDT (1937—1939, Suppl. **15**: 435, T. 27, F. 2—5).
This species is very similar to *G. parvulum* (KÜTZING) GRUNOW, and it is sometimes difficult to distinguish the two species. *G. javanicum* differs in the shape of the valve and slightly also in the structure of the transapical striae. Two examples have been illustrated (Figs. 47, 48).
In the catchment area it occurred in a small number of samples collected mainly from the Klip River and its tributaries.
Figs. 47, 48.
Samples — 335, 354, 364, 431, 436, 445, 449, 451.

G. lanceolatum EHRENBERG (cf. HUSTEDT 1930: 376, F. 700).
Samples — 401, 414, 497.

G. longiceps EHRENBERG (cf. HUSTEDT 1930: 375, F. 704).
Sample — 485.

G. longiceps var. *subclavatum* GRUNOW (cf. HUSTEDT 1930: 375, F. 705).
CLEVE (1894: 183) raised the rank of this variety to that of species, which was later reduced again to var *subclavatum*; however, more recently CHOLNOKY (1966b 185) has once more queried the status of the variety tending to revert to CLEVE's opinion.

G. longiceps var. *subclavatum* is extremely common in South Africa in oligotrophic neutral waters. It was one of the most commonly occurring *Gomphonema* forms in the catchment area, where its distribution was widespread, sometimes occurring abundantly.

G. olivaceum (LYNGBYE) KÜTZING (cf. HUSTEDT 1930 378, F. 719).
Sample — 339.

G. parvulum (Kützing) Grunow (cf. Hustedt 1930: 372, F. 713).
The variability of this species is so great that intermediate forms can be found between all the varieties described by Hustedt (l. c.). The demarcation into varieties appears to be superfluous and serves no purpose at all. With this in mind all forms of *G. parvulum* were included with the typical forms, making one large morphological series. There is a possibility that *G. parvulum* var. *lagenula* is only an ecological phenotype found in slightly more acid waters than the other forms (Cholnoky 1962b: 77). The var. *lagenula* is often retained as a separate taxon, but in this study it has been included with the typical forms of the species.
The autecology of this species has been comprehensively set out by Cholnoky (1962b: 76). One of its most interesting features is the requirement of this species for a fluctuating concentration of dissolved organic materials for its optimal growth. The species cannot, however, tolerate high concentrations of dissolved salts. Its distribution in the catchment area was widespread. It was one of the most common diatom species in the catchment area, and was sometimes recorded in very high numbers.

G. Schweickerdtii Cholnoky (1953a: 143, F. 18, 19).
Samples — 261, 331, 410, 434, 441, 445.

G. sphaerophorum Ehrenberg var. *parvum* Cholnoky (1954a: 416, F. 40).
Sample — 401.

G. subtile Ehrenberg (cf. Hustedt 1930: 376, F. 709).
According to Cholnoky (1962b: 77) the optimum pH value for this species was in the region of pH 6.0. This limited the distribution of this species in the catchment area, and it was reported from one sample collected at Lake Chrissie.
Sample — 485.

Gyrosigma Hassall 1845.

G. acuminatum (Kützing) Rabenhorst (cf. Hustedt 1930: 222, F. 329).
This *Gyrosigma* species is not common in South Africa and was found in five samples from the catchment area.
Samples — 405, 408, 432, 468, 491.

G. acuminatum var. *gallicum* Grunow (cf. Hustedt 1930: 223).
There appears to be only two previous records of this variety from South Africa, one from the Cape Province (Cholnoky 1962a: 31) and the other from the Waterkloof Reservoir near Pretoria made by Huber-Pestalozzi in 1929 (cf. Cholnoky l. c.). In the catchment area it was recorded from one sample from the Grootspruit River, a tributary of the Waterval River.
Sample — 411.

G. Kuetzingii (Grunow) Cleve (cf. Hustedt 1930: 224, F. 333).
This is one of the most common species of *Gyrosigma* in South Africa, and likewise in the Vaal Dam Catchment Area. Cholnoky (1960a: 48; 1960b: 247; 1962b: 77) has reported it from neutral to weakly alkaline waters in South Africa, and similar conditions were commonly found in the catchment area.

G. scalproides (Rabenhorst) Cleve (cf. Hustedt 1930: 226, F. 338).
Together with *G. Kuetzingii* (Grunow) Cleve this species is very common in South Africa and also in the catchment area, since the conditions under which the two species thrive are similar.

G. Spenceri (W. Smith) Cleve (cf. Hustedt 1930: 225, F. 336).
G. Spenceri was found in only two samples from the Vaal Dam Catchment Area, composing 1.0% of the diatom association in sample Vaal 413.
Samples — 403, 413.

Hantzschia Grunow 1880.

H. amphioxys (Ehrenberg) Grunow (cf. Hustedt 1930: 394, F. 747).
In South Africa material Cholnoky (1962b: 78; 1966b: 186) has reported a very wide range of variation in *H. amphioxys*, embracing the var. *africana* Hustedt (1922b: 117) and its *f. minuta* Cholnoky (1955b: 171) within the form range of the typical form. This large range of variation appears to be influenced by the pH value of the water, since the typical forms have been recorded from weakly alkaline to alkaline waters (Cholnoky 1962a: 31); the more densely striated examples (var. *africana* type) from neutral waters (Cholnoky 1962b: 78); and the very small forms (f. minuta type) from weakly acid waters (Cholnoky 1954d: 126; 1955a: 18).
In the alkaline waters of the catchment area the species was recorded from a relatively large number of samples, and the finely and more densely striated examples occurred most commonly.

H. amphioxys var. *vivax* (Hantzsch) Grunow (cf. Hustedt 1930: 394, F. 750).
This variety has not been recorded as commonly from South Africa as the typical forms of the species. In the catchment area it was recorded from only four samples as isolated specimens.
Samples — 306, 353, 478, 479.

H. distincte-punctata Hustedt (1937—1939, Suppl. **15**: 462, T. 40, F. 4).
This is a rarely observed species in South African waters, and has been recorded from neutral to weakly basic waters (Cholnoky 1955a: 18), which have a slightly raised salt concentration (Cholnoky 1966a: 28). In the catchment area it occurred in two samples, one from Station 2A on the Vaal River, and the other from a headwater tributary of the Kaffirspruit River.
Samples — 306, 492.

H. virgata (Roper) Grunow (cf. Hustedt 1930: 395, F. 752).
According to Cholnoky (1955a: 18; 1960a: 49; 1966a: 29) *Hantzschia virgata* is a brackish water form capable of tolerating high osmotic pressures. In addition it prefers waters with a constant high pH value. With this in mind *H. virgata* does not appear to be autochthonous in the Vaal Dam Catchment Area, and it was recorded from just one sample from the Klerkspruit River, near Kestell.
Sample — 362.

Mastogloia Thwaites 1856.

M. elliptica (Agardh) Cleve (cf. Hustedt 1927—1964, Teil 2: 501, F. 927a).
The species is not common in South Africa waters, and is regarded as a brackish water form. No brackish water localities were found in the catchment area; and as a result the species was recorded from one sample from a tributary of the Vaal River near Standerton, and it cannot be autochthonous in this region.
Sample — 420.

Melosira Agardh 1824.

M. distans (Ehrenberg) Kützing (cf. Hustedt 1927—1964, Teil 1: 262, F. 110a—f, i).
Sample — 309.

M. granulata (Ehrenberg) Ralfs (cf. Hustedt 1927—1964, Teil 1: 248, F. 104a—c, e, f).
According to Cholnoky (1962b: 78) *M. granulata* is a true plankton diatom inhabiting relatively eutrophic and weakly alkaline water. Conditions for the proper development of a plankton flora were extremely limited in the region under investigation. Lake Chrissie was perhaps the best suited for planktonic growth. It is therefore not surprising that this species was only recorded from three samples from the catchment area, one of which was collected from Lake Chrissie.
Samples — 306, 485, 486.

M. granulata var. *angustissima* O. Müller (cf. Hustedt 1927—1964), Teil 1: 250, F. 104d).
In material from Dutch New Guinea Cholnoky (1963c: 175) claimed to have found intermediate forms linking the var. *angustissima* to the typical forms of *M. granulata*. However, in the catchment area no such intermediate forms were observed and the variety was retained as a separate taxon.
This variety, var. *angustissima*, occurred far more frequently in the catchment area than the typical forms of the species, although it was never found in large numbers.

M. varians Agardh (cf. Hustedt 1927—1964, Teil 1: 240: F. 100).
According to Giffen (1966: 137) this species is abundant in neutral to slightly acid waters of the Hog's Back Region of the Cape Province. Cholnoky (personal communication) maintained that *M. varians* was nitrogen heterotrophic, and is therefore found in rivers where some organic nitrogenous material is present. In the catchment area the species was recorded from a small number of samples, in some of which the relative density of the species was high. It was recorded mainly from the Klip River System.

Navicula Bory 1824.

N. adsidua n. sp.
In the sample Vaal 338 there were a large number of valves, which were very variable in regard to the valve shape and the shape of the central area. From their structure they belong to the group of diatoms in the section *Naviculae Orthostichae*. In some specimens, however, the central area is relatively well developed for this group of Naviculas. This new species was most like *N. pseudohalophila* Cholnoky (1960a: 74, F. 231—235), but differed in its morphology.
The valves are very variable in shape, linear-lanceolate to broadly elliptical; the poles are in all cases rostrate, but vary in degree — the elliptical forms having broader and less rostrate poles than the more lanceolate valves, which have relatively acutely rounded and rostrate poles; the length of the valves is 18—24 μ, and the width 5.5—7.5 μ. The raphe is straight and filiform; the central pores are not too widely spaced and the terminal fissures are not clear enough to determine their structure. The axial area is narrow and linear and clearly demarcated. The central area is very variable, from circular in some specimens, through elliptical shapes, to entirely absent in others. The transapical striae are quite characteristic of this species; they are fine and the punctae are difficult to distinguish; the striae are slightly radial in the middle and convergent at the poles; the striae are also slightly arcuate, more prominently so at the poles, which probably indicates that the valve surface is slightly concave between the margin of the valve and the raphe; they are slightly wider apart in the middle, about 20—21 in 10 μ, becoming denser towards the poles, about 24 in 10 μ. Occasionally at the central nodule shortened striae are found.
Figs. 49—51.
Valvae late ellipticae, lanceolatae sive linearilanceolatae, apicibus plus minusve protractis. Protractio polorum in valvis ellipticis latior et indistincta, in lanceolatis angustior et melius evoluta. Valvae 18—24 μ longae, 5.5—7.5 μ latae. Rhaphe directa, filiformis poris centralibus parvis, modice approximatis, fissuris terminalibus haud visibilibus. Area axialis distincta anguste linearis, centralis irregularis, in valvis nonnullis circularis, in alteris elliptica sive absens. Striae transapicales distinctae, in media parte valvae levissime radiantes, ad polos versus convergentes, ceterum parallelae, imprimis ad polos versus, probabiliter concameratione superficiei in imagine optica arcuatae, prope nodulum centralem 20—21, ad polos versus usque ad 24 in 10 μ.

Habitat: in fluvio Waterval River sub ponte viae publicae inter pagos Standerton et Leslie ad locum Roodebank Africae Meridionalis.
Typus: praeparatum no. Vaal 338 in collectione C. S. I. R., Pretoria.
Iconotypus: fugurae nostrae no. 49—51.
The species was recorded from a small number of samples from all over the catchment area, occurring most frequently at Station 17, where it was one of the most abundant species in sample Vaal 338.
Figs. 49—51.
Samples — 317, 326, 336, 338, 339, 377, 378, 427.

N. agrestis Hustedt (1937—1939, Suppl. **15**: 246, T. 20, F. 21, 22).
Cholnoky (1966a: 29, F. 70—73) illustrated some specimens of *N. agrestis* from the Okawango and Cunene Rivers of South West Africa. He was, however, a little doubtful of the identity of one (Fig. 73), which differed in structure from the examples. As he was unable to find any other specimens of this type he thought it best to place it with *N. agrestis*. This odd specimen, however, agrees with the description of *N. diuturnoides* Archibald (1966a: 258, F. 17—23), and should be included with it. On account of its parallel or slightly convergent polar striae it cannot be included with *N. agrestis*, whose striae are radial throughout. Two examples from the Vaal Dam Catchment Area have been illustrated (Figs. 52, 53), one of which has relatively thick axial costae enclosing the raphe (Fig. 53).

N. agrestis is rare in South Africa, being reported from the Pienaar's River near Pretoria (Cholnoky 1957c: 67, F. 65) and from the Okawango and Cunene Rivers (Cholnoky 1966a: 29). In the catchment area it was also rare, occurring in very small numbers in a few samples, mainly from the Waterval River.
Figs. 52, 53.
Samples — 358, 403, 410, 411, 412, 455, 512, 552.

N. aquosa Archibald (1966a: 256, F. 7, 8).
Since first describing this species further examples have been observed, necessitating the broadening of the description. In addition to the elliptical — linear-elliptical valves, others have been seen which are lanceolate. Smaller specimens have also been observed so that the range of variation is now: — length 9—13 μ, breadth 3—5 μ and it has 24—26 transapical striae in 10 μ. This range of variation has been illustrated in Figs. 54—57.

N. aquosa was not particularly common in the region under investigation, but was found throughout the area in small numbers.
Figs. 54—57.

N. arvensis Hustedt (1937—1939, Suppl. **15**: 249, T. 17, F. 40, 41).
Fig. 58.
Sample — 410.

N. atomus (Kützing) Grunow (cf. Hustedt 1927—1964, Teil **3**: 169, F. 1303).
The systematics of this species is confusing. Firstly there appears to be some controversy over the type specimens of this species, some attributing the species to *Amphora? atomus* Kützing and some to *Synedra atomus* Naegeli. De Toni (1891: 166) quoted *Amphora? atomus* described by Kützing in 1844 as the type of the species, as *Synedra atomus* was described five years later by Naegeli. According to Patrick and Reimer (1966: 488) Kützing himself in his "Species Algarum" wrote "Synedra atomus in litt. = Amphora? atomus Kützing". It therefore appears that the species should be attributed to Kützing; this species was then later transferred to the genus *Navicula* by Grunow. Secondly the morphology of the species, in particular the number of transapical striae, is in need of discussion. The older descriptions give the number of striae as 30 in 10 μ, and this led to the description of two new species, *Navicula caduca* Hustedt and *Navicula pseudatomus* Lund, having 18—20 transapical striae in 10 μ. Later, however, Hustedt was able to study Grunow's material and was able to establish that *N. caduca* and *N. pseudatomus* were synonymous with *N. atomus*. The number of transapical striae in *N. atomus* therefore varies between 19 and 30. The specimens found in the catchment area generally contained 28—30 striae in 10 μ.
The species appears to favour weakly alkaline waters in South Africa (Cholnoky 1958c: 317), and was found quite frequently in the catchment area, being present in some samples in relatively high numbers.

N. avenacea Brébisson (cf. Hustedt 1957: 288).
Samples — 309, 325, 451, 554.

N. bacilloides Hustedt (1945: 922, T. 42, F. 29).
This appears to be the first record of this species (Figs. 58, 59) in South Africa. While there is no doubt concerning the identity of these specimens, they showed a wider range in the number of transapical striae per 10 μ. The examples from the catchment area had between 18 and 24 striae in 10 μ.
The specimens were recorded from a few samples collected over the whole catchment area, but it was never abundant.
Figs. 58, 59.
Samples — 236, 251, 334, 344, 363, 422, 429, 432, 441, 493, 495, 511.

N. bacillum Ehrenberg (cf. Hustedt 1927—1964, Teil **3**: 113, F. 1248a—d).
Sample — 403.

N. barbarica Hustedt (1949a: 97, T. 4, F. 14—17).
N. barbarica has not previously been found outside the Belgian Congo, where it was originally described by Hustedt (l. c.). The specimen illustrated in Fig. 60 agreed in every detail with Hustedt's diagnosis, and left no doubt as to the identity of this specimen. This

Vaal River and the other from a tributary stream of the Vaal River near Standerton.
Figures 97, 98.
Samples — 375, 420.

N. gregaria DONKIN (cf. HUSTEDT 1930: 269, F. 437).
Sample — 404.

N. Grimmei KRASSKE (cf. HUSTEDT 1927—1964, Teil **3**: 769, F. 1742).
According to CHOLNOKY (1960a: 63) *N. Grimmei* (Fig. 99) is widespread in neutral to weakly alkaline waters, and has a pH optimum of around pH 7.0. In the catchment area the species was found in many samples, but with low relative densities in the associations. This probably indicated that the pH of the water in the catchment area is generally higher than pH 7.0.
Figure 99.

N. halophila (GRUNOW) CLEVE (cf. HUSTEDT 1927—1964, Teil **3**: 64, F. 1209).
As its name implies this species finds its optimum development in brackish or saline waters. It is therefore not surprising that this species was found in such small numbers in the catchment area. It was found as isolated specimens in five samples.
Figures 100—102.
Samples — 330, 343, 411, 468, 477, 554.

N. Hambergii HUSTEDT (1924: 562, T. 17, F. 2; 1937 bis 1939, Suppl. **15**: 263, T. 18, F. 35—37 — under *N. quadripartita* HUSTEDT).
CHOLNOKY (1954c: 283) has reported the occurrence of some small examples of this species from South Africa; these specimens were only 12 μ long. The small specimen (Fig. 103), observed from Lake Chrissie, supported CHOLNOKY's observations in this regard, being only 14 μ long, and 6 μ broad.
Although CHOLNOKY (1960a: 64) stated that this well defined species appears to be widely distributed in South Africa, it was found in only two samples from the catchment area, one from Lake Chrissie and the other from the Kleinkaffirspruit near Ermelo.
Figure 103.
Samples — 485, 489.

N. hungarica GRUNOW var. *capitata* (EHRENBERG) CLEVE (cf. HUSTEDT 1930: 298, F. 508).
The variety occurs more commonly than the typical forms of the species, and in the catchment area only the variety was observed. It is usually found in weakly alkaline waters (CHOLNOKY 1962b: 85), and as a result it occurred in many samples from the region under survey but never in great abundance.

N. Hustedtii KRASSKE (cf. HUSTEDT 1930: 274, F. 449).
Sample — 411.

N. insociabilis KRASSKE (cf. HUSTEDT 1927—1964, Teil **3**: 183, F. 1317, under *N. monoculata* HUSTEDT).
According to CHOLNOKY (personal communication) the iconotypes of *N. insociabilis* are the figures in A. SCHMIDTS Atlas T. 400, F. 103—105, drawn by HUSTEDT from marked specimens on the original slide of KRASSKE. In CHOLNOKY's opinion these drawings are the same as those of *N. monoculata* HUSTEDT, and therefore *N. insociabilis* and *N. monoculata* are the same species, *N. monoculata* thus being a synonym. HUSTEDT (l. c.) however was correct in regarding *N. pseudagrestis* as synonymous with *N. insociabilis* (= *N. monoculata*). Figure 104 illustrates an example of this species from the catchment area.
Little is known of the autecology of this species. In the catchment area it was recorded from Stations 3,5 and 19 in the Vaal River, from a sample collected near Memel, and from some scattered localities in the Wilge River System.
Figure 104.
Samples — 240, 332, 365, 417, 422, 429, 441, 493, 495.

N. Lamii MANGUIN (1941: 155, Pl. 1, F. 7).
According to CHOLNOKY (personal communication) both *N. indifferens* HUSTEDT (1927—1964, Teil **3**: 84, F. 1226) and *N. pascuorum* CHOLNOKY (1965: 72, F. 24, 25) are in fact synonyms of *N. Lamii* MANGUIN. This serves to emphasize the comments made earlier on the small hyaline Navicula forms (see *N. difficillima*), that they are very difficult to identify with certainty. The shape and dimensions of the valve are generally variable with the result that the same species can be described by more than one author under different names, as has happened in this instance.
The distribution of *N. Lamii* in the catchment area wa[s] widespread, but it occurred in low relative densities i[n] the diatom associations.
Figures 120, 121 (*N. pascuorum* type). Cholt. 1957 + 1965.

N. letulenta n. sp. Compare with N. aurorae
This new species falls into the group of *Naviculae* simila[r] to *N. Hambergii* HUSTEDT (1924: 562, T. 17, F. 2), an[d] appears to be most closely related to *N. Hambergii.* differs from the latter in its morphology, having a rela[tively] narrower valve, a relatively broader axial area an[d] a more coarsely striated valve.
The valve is lanceolate with relatively acutely rounde[d] and rostrate poles, 17.5—20 μ long, and 5—6 μ wid[e]. The raphe is straight and filiform with relatively lon[g] slightly luante polar fissures, which curve in the sam[e] direction. The axial area is narrow at the poles, but wide[ns] into a lanceolate area occupying about one third of t[he] valve width. The central area is consequently absen[t]. Due to the lanceolate axial area the transapical striae a[re] relatively short, projecting about one third of the way to the valve. In the central part of the valve there a[re] many irregularly shortened striae, sometimes giving alternately longer and shorter pattern; they are sometim[es] found to be irregular in the arrangement; the str[iae] around the central nodule are also somewhat arcu[ate] but in no defined manner; they number about 18 in 10 and are radial in the middle and parallel to slightly c[on]vergent at the poles.
Figures 106, 107.

Valvae lanceolatae apicibus rostratis et acutiuscule rotundatis, 17.5—20 μ longae, 5—6 μ latae. Rhaphe directa, filiformis, fissuris terminalibus seimcircularibus, in relatione longis, in eodem sensu curvatis. Area axialis in vicinitate polorum anguste linearis, ad nodulum centralem versus lanceolatodilatata, tertiam partem latitudinis valvae occupans. Area centralis nulla. Striae transapicales breves, in media parte valvae radiantes, ad polos versus leviter convergentes, circiter 18 in 10 μ. In vicinitate noduli centralis striae plures abbreviatae, irregulariter distributae, intercalatae sunt.
Habitat: in rivulo Kaffirspruit dicto sub ponte viae publicae inter pagos Morgenzon et Ermelo provinciae Transvaalensis in Africa Meridionale.
Holotypus: praeparatum no. Vaal 344 in collectione C. S. I. R., Pretoria.
Iconotypus: figurae nostrae no. 106 et 107.
Only three specimens of this new species were recorded in the catchment area, one from the Waterval River, one from the Kaffirspruit stream and the other from the Russespruit Stream.
Figures 106, 107.
Samples — 344, 363, 412.

N. libonensis SCHOEMAN (1969a: in press; 1969b: 52, F. 42, 43).
Examples of this species occuring in the catchment area fell within the limits described by SCHOEMAN (l. c.), and there can be no doubt that these examples belong to his species, *N. libonensis*. In the early part of this study similar specimens were described as *N. Schubartii* var. *africana* nov. var. (ARCHIBALD 1966a: 261, F. 13). However, the forms assigned to this variety were later recognised as a species of its own, bearing a similarity to *N. Schubartii* HUSTEDT (1952a: 396, F. 104), and were subsequently independently described by SCHOEMAN.
N. libonensis was widely distributed in the catchment area, and at some localities it was relatively abundant. Little is known at present about its ecological requirements.
Figures 176—178.

N. longicephala HUSTEDT (1943: 277, F. 17).
One of the specimens observed in the catchment area material was slightly aberrant in having slightly undulating side lines (Fig. 108) instead of the normal parallel margins.
In the catchment area two specimens were observed from two samples, one at station 1 on the Vaal River and the other from Lake Chrissie.
Figure 108.
Samples — 301, 485.

N. manubialis ARCHIBALD (1966a: 260, F. 29).
Figures 109, 110.
Samples — 406, 512.

N. Mengeae CHOLNOKY (1954a: 418, F. 58—60).
A single specimen of this rare species (Fig. 273) with a slightly narrower valve than described (3 μ instead of 4.5 μ) was recorded from Station 24 on the Klip River.
Figure 273.
Sample — 358.

N. microcephala GRUNOW (cf. HUSTEDT 1927—1964, Teil **3**: 258, F. 1385).
There is some doubt concerning the correct identification of this small *Navicula* species. Forms originally assigned to the new species *N. subarvensoides* ARCHIBALD (1966a: 262, F. 39) are now thought to be more correctly identified with *N. microcephala*. Such forms (Fig. 139) appeared to be intermediate between those examples of *N. microcephala* having 36 transapical striae in 10 μ (Figs. 111 to 113) and those in which the striae were too fine to be seen (Fig. 114). All these forms were generally weakly silicified, lienar-lanceolate in shape and slightly protracted at the poles.
N. microcephala was found in a relatively large number of samples from the catchment area, but, due to its preference for a neutral to acid pH value of the water (CHOLNOKY 1962b: 86), it did not occur in very high numbers in the samples.
Figures 111—114, 139.

N. minima GRUNOW (cf. HUSTEDT 1927—1964, Teil **3**: 249, F. 1374).
The catchment area examples of this species were generally very small, ranging from 5.5—6.0 μ in length.
In the region under study it was recorded in small numbers in a number of samples from a widespread area.

N. minuscula GRUNOW (cf. HUSTEDT 1927—1964, Teil **3**: 254, F. 1381).
Some irregular forms (e. g. Fig. 115) have been assigned to this species since they are more akin to *N. minuscula* than any other species. These forms were elliptic-lanceolate, 8.5 μ long and 3.5 μ broad, and had convergent transapical striae at the poles. CHOLNOKY (1959: 44, F. 237) has also reported similar small examples.
Figure 115.
Samples — 321, 337, 402, 408.

N. molesta KRASSKE (cf. HUSTEDT 1927—1964, Teil **3**: 252, F. 1379).
There is little doubt that the specimens assigned to this species are indeed *N. molesta*, since they agree very well with the description given by HUSTEDT (l. c.). There were, however, some small differences as some specimens were slightly longer (measuring up to 21 μ long) and some had protracted but not capitate poles. Three examples have been illustrated in Figures 116—118. This species has previously only been reported from arctic freshwater habitats in the Spitzbergen by KRASSKE, and it thus constitutes a new record for South Africa. It was recorded in the catchment area from Station 1 on the Vaal River, Station 17 on the Waterval River, and from Lake Chrissie.
Figures 116—118.
Samples — 301, 340, 479, 485.

N. montisatrae CHOLNOKY (1959: 45, F. 239, 240).
The specimen (Fig. 119) found in the catchment area differed from CHOLNOKY's description in one respect in

that the polar striae were less radial to almost parallel. In all other respects it agreed with the description.
As this species is very rarely seen its autecology remains unknown. It was recorded from one sample collected from the Vaal River.
Figure 119.
Sample — 321.

N. muralis Grunow (cf. Hustedt 1927—1964, Teil 3: 236, F. 1359).
Cholnoky (1960b: 252; 1962b: 87) studied the diatom associations in relation to the stages of sewage purification at the Pretoria and Johannesburg Sewage Works, following the succession of one diatom association to another as the water was progressively purified. He was thus able to study the autecology of *N. muralis*, among others, in fairly close detail. Cholnoky found that it was able to reproduce at pH values between 7.5—8.5 with an optimum lying around pH 8.0. According to Cholnoky the species is not nitrogen autotrophic (i. e. utilising inorganic nitrogen as its nitrogen source), but thrived best in conditions where, due to the purification processes, there was a decline in the concentration of the organic nitrogenous compounds (i. e. below 5.0 mg. N/litre). It replaces the nitrogen heterotrophic *Nitzschiae* when the concentration of organic nitrogen falls below their optimum. As *N. muralis* also requires a high oxygen content it is generally the dominant diatom species at the end of a purification process, when the oxygen content is high and the organic nitrogen concentration of the water lies between 1.0 and 5.0 mg. N/litre. It is replaced by other algae when the organic nitrogen concentrations are less than 1.0 mg. N/litre.
Its distribution in the catchment area was widespread, appearing in a very large number of samples from the whole region.

N. mutica Kützing (cf. Hustedt 1927—1964, Teil 3: 583, F. 1592a—f).
The systematics of this species and the group of diatoms to which it belongs appears to be particularly confused, with added confusion caused by Hustedt's latest treatment of the group (cf. Hustedt l. c.), and it thus appears that this species and its related forms and varieties is in need of a thorough revision. Cholnoky (1954d) has claimed that the more delicately structured forms found in acid waters were due to the physical conditions of the water, since more normal examples were commonly observed in alkaline water.
In the catchment area the species, although found in a number of samples, was never abundant in any of the samples.

N. mutica var. *nivalis* (Ehrenberg) Hustedt (cf. Hustedt 1930: 275, F. 453c).
Recently Hustedt (1927—1964, Teil 3: 620) has reinstated this variety as *Navicula nivalis* Ehrenberg on the grounds that these capitate forms are not related to *N. mutica*. Nevertheless it seems suprising that *N. mutica*, being such a variable form, should have no forms with capitate poles, particularly as there are many forms with protracted ends to the valves. In this study the variety, var. *nivalis*, has been retained as there seems to be insufficient evidence warranting a complete separation of the variety and the typical forms. Var. *nivalis* may prove to be an ecological phenotype, since its autecology differs slightly from the typical forms of *N. mutica* (Cholnoky 1962b: 87). An unusual form (Fig. 151) from the Kommandospruit stream (Vaal 445), resembling *N. mutica* var. *nivalis* in valve shape, differed from this variety in having a more densely striate valve surface (about 28 striae in the middle and about 34 striae in 10 μ at the poles). This falls outside the range of variation (16—24 striae in 10 μ) given for this variety by Bock (1963: 236). It is possible that this specimen enlarges the range still further.
The var. *nivalis* was not as common in the catchment area as the typical forms of *N. mutica*. It was recorded mainly form the Vaal River.
Figure 151.
Samples — 301, 307, 334, 342, 348, 359, 370, 418, 479.

N. muticoides Hustedt (1949a: 82, T. 4, F. 33—36).
Due to the position of the isolated pore close to the valve margin and its much finer striation, this species is quite clearly distinguishable from *N. mutica* Kützing. The autecology of the species is not properly known since it occurs very rarely. It was recorded from Station 31 on the Kommandospruit River, and from Stations 10 and 11C on the Wilge River.
Samples — 330, 333, 445.

N. nyassensis O. Müller (cf. Hustedt 1949a: 88, T. 5, F. 20).
Cholnoky (1966a: 40; 1966b: 192) has drawn attention to the need for a revision of the systematics of this species. The distinction between *N. nyassensis* and *N. pupula* Kützing are very small indeed, so that on occasions it becomes difficult to separate the two species. In this study the criteria used for distinguishing the two species were the number of striae in the region of the central nodule and the appearance of the central area. *N. pupula* has 21 or more striae in 10 μ at the central nodule and the central area is usually clearly demarcated and rectangular in outline, while *N. nyassensis* has 18 striae in 10 μ at the central nodule with an indistinctly defined central area, which is more oval in outline.
N. nyassensis has been reported neutral to weakly basic waters in South Africa. In the catchment area it was rare and was recorded in a relatively small number of samples.
Samples — 306, 307, 309, 312, 350, 353, 403, 411, 449, 464.

N. permitis Hustedt (1927—1964, Teil 3: 174, F. 1306).
N. permitis is yet another of these small hyaline *Navicula* species. It is very closely related to *N. pelliculosa* (Brébisson) Hilse (cf. Hustedt 1927—1964, Teil 3: 173) from which it was separated by Hustedt on the basis o

its narrower valves and less well developed axial rib. HUSTEDT (l. c.) has also noted that *N. nolens* SIMONSEN (cf. HUSTEDT l. c.: 174) differed from *N. permitis* only on account of its physiology, i. e. *N. nolens* being marine and *N. permitis* being a freshwater species. In this survey some unusually small hyaline diatoms were observed, having a more or less constant length of 6 μ and width of about 2 μ (Fig. 122). Generally only the raphe and axial area were clearly visible, as the valve wall was extremely weakly silicified. The valves, when just visible, were linear-elliptical to lanceolate. On the basis of the shape of the valve these small specimens have been referred to this species. If this identification is correct, then these measurements enlarge the range of variation for the species.
The autecology of *N. permitis* is not known, and the few typical examples of this species seen in the catchment area throw no light on the matter. Mention must be made, however, of the unusual small forms. In the sample Vaal 377 they composed 88.7% of the diatom association, and in Vaal 378 about 14.4% of the association. Both these samples were collected from the Waterval River at Roodebank (Station 17) where, from the composition of the diatom association in other samples from this point, there is evidence of large concentrations of organic nitrogenous compounds in solution. This may therefore indicate that these small forms are nitrogen heterotrophic, i. e. depend on organic nitrogen as their nitrogen source.
Figures 122—124.

N. perparva HUSTEDT (1927—1964, Teil **3**: 283, F. 1355).
CHOLNOKY (1960b: 253; 1962b: 88) recorded this uncommon species from polluted waters and remarked that its autecology is similar to that of *N. muralis*. This means that the species is found where the trophic conditions are no longer optimal for the nitrogen heterotrophic *Nitzschiae* but the water still contains some organic nitrogen in solution. The distribution of the species in the catchment area appeared to substantiate this, as it was recorded mainly from the Waterval River, where the water apparently contained sufficient organic nitrogen.

N. promota n. sp.
N. promota belongs to the group *Naviculae Orthostichae* (CLEVE) HUSTEDT, and has some affinity to *N. cuspidata* KÜTZING var. *ambigua* (EHRENBERG) CLEVE (cf. HUSTEDT 1927—1964, Teil **3**: 62). It differs from this variety in the possession of a more densely striated valve surface and a well defined central area. The new species cannot apparently be associated with any other *Navicula* of this group.
The valves are lanceolate with rostrate to slightly capitate poles, 32.5—40 μ long, and 7—9 μ wide. The raphe is straight and filiform; the central pores are inconspicuous and are not hooked; the terminal fissures are small, lunate and are curved towards the same side of the valve. The axial area is narrow and linear; at the central nodule it widens to form an oval to circular central area, about one third of the valve width in breadth. The transapical striae are slightly radial in the middle and convergent at the poles, 20—24 in 10 μ; the longitudinal costae are indistinct.
Figure 125.
Valvae lanceolatae apicibus rostratis sive leviter capitato-rostratis, 32.4—40 μ longae, 7—9 μ lataeque. Rhaphe filiformis directa, poris centralibus minutis, sine fissuris hamuliformibus, fissuris terminalibus brevibus semicircularibus, in eodem sensu curvatis. Area axialis anguste linearis, prope nodulum centralem in aream centralem ellipticam sive circularem, tertiam latitudinis valvae occupantem transiens. Striae transapicales in media parte valvae leviter radiantes, ad polos versus convergentes, ceterum parallelae, 20—24 in 10 μ. Costae longitudinales indistinctae.
Habitat: in palude prope pagum Memel in agro Welgelegen Africae Meridionalis.
Typus: praeparatum no. Vaal 478 in collectione C. S. I. R., Pretoria.
Iconotypus: figura nostra no. 125.
This new species was found in a number of samples from the Vaal River System, and in two others from Station 24 on the Klip River, and in a sample from the Cornelius River. In none of the samples was the species common.
Figure 125.

N. pseudohalophila CHOLNOKY (1960a: 74, F. 231—235).
It appears that the examples of this species found in the catchment area are the first records of *N. pseudohalophila* from the Transvaal. The species appeared to be limited to the Waterval River, which was found to be slightly mineralised from mining activities in its upper reaches.
N. pseudomuralis HUSTEDT (1937—1939, Suppl. **15**: 245, T. 19, F. 25—27).
Sample — 498.

N. pseudoventralis HUSTEDT (1927—1964, Teil **3**: 153, F. 1285).
In this survey the small specimens of this species were easily identified as *N. pseudoventralis*. As the species has been so seldom seen in South Africa two examples (Figs. 126, 127) have been illustrated.
This species was observed in six samples, mainly from the Waterval River.
Figures 126, 127.
Samples — 324, 337, 339, 340, 436, 485.

N. pupula KÜTZING (1927—1964, Teil **3**: 120, F. 1254 a—g).
CHOLNOKY has recorded this species from neutral to weakly alkaline water containing very little organic nitrogenous compounds (CHOLNOKY 1960a: 75; 1960b: 253; 1962a: 45; 1962b: 88). Under the suitable conditions of the catchment area *N. pupula* was amongst the commonest and most widespread in distribution.

N. pupula f. *rostrata* HUSTEDT (1927—1964, Teil **3**: 121, F. 1255).
There is some discrepancy between the description and figures of the f. *rostrata* given by HUSTEDT in the Bacillariophyta (HUSTEDT 1930: 282, F. 467e) with those

given by him in RABENHORST (HUSTEDT 1927—1964, Teil **3**: 121, F. 1225). The illustration of f. *rostrata* in the Bacillariophyta is more like the drawing of *N. pupula* var. *mutata* (KRASSKE) HUSTEDT given in RABENHORST. The description of f. *rostrata* in the two books also do not tally, as the f. *rostrata* is described as having capitate poles in RABENHORST, while in the Bacillariophyta no mention is made of capitate poles. In a later publication HUSTEDT (1946—1950: T. 37, F. 21—23) has illustrated some small specimens of f. *rostrata* having protracted but not capitate poles. Two specimens from the catchment area have been tentatively assigned to this form, one showing slightly capitate poles (Fig. 129), and the other being similar to the smaller forms without capitate poles (Fig. 128) and measuring 9 μ long and 4 μ broad.
This form has not been recorded from South Africa before. In the catchment area it was recorded from a sample from Lake Chrissie and one from a tributary of the Sand River.
Figures 128, 129.
Samples — 455, 485.

N. pupuloides CHOLNOKY (1955b: 175, F. 62, 63).
Sample — 309.

N. pygmaea KÜTZING (cf. HUSTEDT 1930: 312, F. 561).
This species has been recorded in South Africa from both fresh water and from waters containing higher than normal concentrations of dissolved salts. CHOLNOKY (1958b: 121; 1960a: 76; 1962b: 88) recorded it from alkaline watres and remarked that in the Zwartkops River (CHOLNOKY 1960b: 253) „Die Art erweist sich hier als eine richtige Salzwasserart". Previously he had recorded it only from fresh waters. In the freshwaters of the catchment area it was generally found as single specimens, although in one or two samples it was relatively abundant.

N. rhynchocephala KÜTZING (cf. HUSTEDT 1930: 296, F. 501).
CHOLNOKY (1960a: 78; 1962a: 45; 1962b: 89) has reported this species as widely distributed in the alkaline waters in South Africa. The alkaline conditions prevailing in the catchment area appeared to suit the development of this species. It was found in nearly all the samples from the catchment area, and on some occasions was relatively abundant.

N. rostellata KÜTZING (cf. HUSTEDT 1930: 297, F. 502).
According to CHOLNOKY (1960a: 78; 1962: 89) *N. rostellata* is found in alkaline waters of South Africa having a poor concentration of organic nitrogen. This probably accounts for its wide distribution in the catchment area, where it was one of the most commonly occurring diatoms, sometimes being found in relatively high numbers.

N. Ruttneri HUSTEDT (1937—1939, Suppl. **15**: 238, T. 17, F. 18—23).
Sample — 432.

N. Schroeteri MEISTER (cf. HUSTEDT 1937—1939, Suppl. **15**: 267, T. 18, F. 16).
Among the many examples of this species two types of valve have been observed. While the dimensions of both types remained the same, and a complete range of intermediates existed, one type was more strongly silicified with larger lineolae, whereas the other was weakly silicified with smaller lineolae. This may be the result of different physical conditions in the water.
The species apparently inhabits alkaline waters and has a pH optimum of about pH 8. Although CHOLNOKY (1962b: 89) remarked that this species cannot tolerate fluctuations of the pH value to the acid side, GIFFEN (1966: 141) has recorded it as plentiful in neutral to slightly acid waters of the Hog's Back Region. The pH values of the waters in the catchment area were generally above pH 8, and were found to be below neutral point at only two stations. *N. Schroeteri* was recorded at neither of these two stations. In the remainder of the catchment area *N. Schroeteri* was recorded in many samples and was sometimes present in relatively high numbers in the associations. This tended to support CHOLNOKY's findings rather than those of GIFFEN. CHOLNOKY (personal communication) has suggested that this species is influenced by the presence of sugars in solution, as it is of common occurrence in the Nonoti River in Natal, where wastes from a sugar mill enrich the water.

N. Scottiae CHOLNOKY et CLAUS (1961: 334, F. 15, 16).
This specimen of *N. Scottiae* agreed with the morphological characteristics described by CHOLNOKY (l. c.) in all details, but it differed in its dimensions, being slightly larger than those given in the description. The length of this example (Fig. 130) was 16.5 μ and its breadth 5 μ, the striae in the middle of the valve numbered 18 in 10 μ and became a little denser towards the poles.
N. Scottiae has previously only been recorded from its type locality, and as a result very little is known of its autecology. One specimen was recorded from the catchment area at Station 3 on the Vaal River.
Figure 130.
Sample — 495.

N. seminuloides HUSTEDT (1927—1964, Teil **3**: 244, F. 1369).
N. seminuloides is apparently acidophil (CHOLNOKY 1958b: 122; 1960b: 255), and this probably accounted for its relatively small occurrence in the alkaline waters of this region.
Samples — 249, 324, 328, 402, 406, 412, 419, 497, 498, 513.

N. seminulum GRUNOW (cf. HUSTEDT 1927—1964, Teil **3**: 241, F. 1367).
Two examples of this species have been illustrated (Figs. 131, 132), one of which had a slightly denser striation than normal, yet in all other respects this example conformed to the description of the species. It was recorded from a relatively small number of samples from scattered localities in the catchment area.
Figures 131, 132.

N. simplex KRASSKE var. *minor* CHOLNOKY (1954a: 419, F. 62).
The variety (Fig. 135) occurred in low number in a few samples from the catchment area.
Figure 135.

N. soehrensis KRASSKE f. *capitata* (KRASSKE) HUSTEDT (1927—1964, Teil 3: 215, F. 1331e).
This small form of *N. soehrensis* is rare in South Africa, and has only been recorded on two previous occasions. It is apparently a pan-tropical form, and in South Africa has not been found further south than the Transvaal. In the catchment area it was recorded as isolated specimens in only two samples from the Vaal River.
Samples — 403, 477.

N. soehrensis f. *muscicola* (BOYE PETERSEN) KRASSKE (cf. HUSTEDT 1927—1964, Teil 3: 215, F. 1331f—h).
CHOLNOKY (1962a: 46 and 1964: 73) has presented two completely opposing views on the systematics of this form of *N. soehrensis*. In the earlier paper he advocated the separation of the f. *muscicola* from the typical forms of the species, while in the later publication he maintained that the two forms were the same and a separation of the forms served no purpose. In the latter case CHOLNOKY, having united the two forms, gave them the new combination *Navicula muscicola* (BOYE PETERSEN) CHOLNOKY. However, following the rules of priority the epithet "soehrensis" was validly used in 1923 by KRASSKE five years before BOYE PETERSEN's *Pinnularia muscicola* was described. The correct combination should therefore be *Navicula soehrensis* KRASSKE, with *P. muscicola* as a synonym. However, in this study the various forms of the species *N. soehrensis* have been retained as so few specimens have been observed, making systematic comments difficult. From material collected in the Cape Province CHOLNOKY (1961a: 46, F. 60—63) illustrated some examples of *N. soehrensis* f. *muscicola*. However, in the author's opinion the Fig. 60, with its straight walls and capitate poles, belongs to *N. soehrensis* f. *capitata* rather than to *N. soehrensis* f. *muscicola*, which does not have capitate poles. Two examples from the catchment area (Figs. 133, 134) have been drawn to illustrate this form.

N. soehrensis f. *muscicola*, an acidobiont (CHOLNOKY 1955b: 177), was found in a small number of samples as isolated specimens.
Figures 133, 134.
Samples — 203, 309, 331, 334, 359, 360, 434, 436, 456.

N. spirata HUSTEDT (1927—1964, Teil 3: 237, F. 1361).
Sample — 307.

N. Standeriella ARCHIBALD (1966a: 262, F. 37, 38).
The discovery of further examples of this species has widened the range of variation. Some shorter specimens were observed in a sample from Station 5a on the Vaal River; the minimum length of the valves in the sample were 9.5 μ.
The species was recorded from the Kalk River and the Waterval River.
Figures 136—138.
Samples — 321, 402, 553.

N. subatomoides HUSTEDT (1927—1964, Teil 3: 271, F. 1400).
Samples — 333, 359, 437, 485.

N. subbacillum HUSTEDT (1927—1964, Teil 3: 117, F. 1251).
Three specimens from the tributaries of the Vaal River have been identified as *N. subbacillum*. They provided the first record of this species for South Africa.
Samples — 465, 468, 491.

N. subcoccus CHOLNOKY (1960a: 80, F. 247, 248).
There has only been one previous record of this species (Fig. 140) and that was from the type locality, the Oribi Gorge in Natal. The examples of this species from three localities near the source of the Vaal River provided the first record of *N. subcoccus* outside its type locality. One or two valves were seen in each sample.
Figure 140.
Samples — 301, 479, 485, 486.

N. subcostulata HUSTEDT var. *avittata* CHOLNOKY (1959: 51, F. 265—269).
Figure 141.
Sample — 402.

N. subhamulata GRUNOW (cf. HUSTEDT 1927—1964, Teil 3: 126, F. 1258).
This diatom species, easily recognised by its long terminal fissures and the slightly sunken portion of the valve surface, occurred in a number of samples in its typical form, generally as isolated examples but on occasions with relatively high percentage densities. CHOLNOKY (1957a: 62; 1962b: 90) has found *N. subhamulata* in neutral to weakly alkaline water, and claims that its optimum pH value lies around pH 7.0.

N. submolesta HUSTEDT emend. ARCHIBALD (1966a: 263, F. 34).
A series of specimens from the catchment area (Figs. 142 bis 150) emphasised the gradation from the typical *N. submolesta* (Fig. 148) with 17 straie in 10 μ in the middle and 24 at the poles, through intermediate forms to the typical *N. molestiformis* HUSTEDT (1949a: 86) containing 27 striae in the middle and 34 striae at the poles (Fig. 150). Furthermore the wide range of valve shape has made it necessary for the description to be amended taking into account the observations made from these specimens. The valves of *N. submolesta* are thin-walled, linear, linear-lanceolate to elliptical-lanceolate, with short rostrate poles, 14—21 μ long, and 3.5—6.5 μ wide. The raphe is straight and filiform, sometimes with the central pores widely separated. The axial area is narrow and linear, and there is no central area. The transapical striae are parallel throughout, although sometimes they may be slightly convergent at the poles, in the middle 17—30 striae in 10 μ, and more dense at the poles 21—35 in 10 μ.

The species was relatively common throughout the catchment area, but never occurred with any great abundance in any of the samples.
Figures 142—150.

N. subrotundata Hustedt (1926—1964, Teil 3: 272, F. 1402a—m).
Two specimens (Figs. 152, 153) have been assigned to *N. subrotundata*, as they fulfil the requirements for the description of the species.
In the catchment area it was reported from the Waterval River (Station 17), the Vaal River (Stations 2 and 2A), the Klerkspruit River near Kestell and from Lake Chrissie.
Figures 152, 153.
Samples — 306, 340, 362, 485, 486.

N. subtilissima Cleve (cf. Hustedt 1927—1964, Teil 3: 89; F. 1235, 1236).
In the catchment, on account of its low pH optimum, it was found in only two samples, one from the headwaters of the Vaal River (Station 1) where the water is acidic, and the other from further down the Vaal River (Vaal 307).
Samples — 307, 479.

N. tantula Hustedt (1927—1964, Teil 3: 250, F. 1375).
Among the many typical examples of this species (Fig. 156) some very short forms showing a more elliptically shaped valve were observed (Fig. 154).
The autecology of this species has not yet been accurately determined. Cholnoky (1957a: 67) has found it to be widespread in certain acid waters, and occasionally in neutral to weakly alkaline waters (Cholnoky 1960a: 64). From the distribution of the species in the catchment area it would appear that the species was capable of thriving equally well in waters that are generally alkaline. *N. tantula* was recorded from many samples collected all over the catchment area.
Figures 154—156.

N. temeraria Cholnoky (1965: 73, F. 28, 29).
Two specimens of this species were observed in the catchment area. A small form (Fig. 157) whose dimensions were 10 μ long and 6.5 μ broad was recorded from Station 2A on the Vaal River, while a form with a prominent axial rib enclosing extremely thick raphe branches (Fig. 158) was found in Lake Chrissie, the type locality of the species.
Figures 157, 158.
Samples — 307, 485.

N. tenella Brébisson (cf. Hustedt 1930: 299, under *N. radiosa* var. *tenella*).
In recent times Cholnoky (1962b: 88; Cholnoky et Claus 1961: 335) has maintained that the var. *tenella* has little to do with *N. radiosa* except for a superficial similarity, and has therefore reconstituted Brébisson's species, *N. tenella*. This concept has been followed during the course of these investigaitons, but since the definition of this species is not clear some examples have been drawn depicting what is thought to be the true *N. tenella* Brébisson (Figs. 159—161). The valve is lanceolate with acutely rounded ends. The axial area is linear and narrow, and widens very slightly at the central nodule to form a small lanceolate central area. The transapical striae are prominent and number about 14 in 10 μ, radial in the middle and convergent at the poles. Generally the central striae are long almost reaching the axial area. On either side of these central striae there are usually shortened striae, which give them the appearance of being alternately longer or shorter at the central nodule. This appeared to be one of the characteristic features of these examples.

N. tenella was widespread in the alkaline waters of the Vaal Dam Catchment Area, sometimes occurring in very high numbers in the samples. It was one of the commonest *Navicula* species found in the catchment area.
Figures 159—161.

N. tenellaeformis Hustedt (1937—1939, Suppl. 15: 269, T. 19, F. 14, 15).
There is some uncertainty over the identification of all the specimens assigned to this species. Of the three specimens that were illustrated, figure 164 showed the more typical form of *N. tenellaeformis*. However, figures 162, 163 showed irregularities of the valve form and arrangement of the transapical striae, and have been allotted to this species on account of their similarities to this species.
N. tenellaeformis was observed as isolated specimens in a few samples collected from scattered localities in the Waterval, Vaal and Klip River Systems.
Figures 162—164.

N. tenelloides Hustedt (1937—1939, Suppl. 15: 269, T. 19, F. 13).
This species is apparantly widespread in the neutal to weakly alkaline waters of South Africa, and according to Cholnoky (1962b: 91) it finds its optimal development in weakly alkaline water. It was therefore not surprising to find this species so widely distributed throughout the catchment area, where it sometimes occurred ir relatively high proportions.

N. tenuissima n. sp.
This new species belongs to the group *Naviculae subtilissimae* Hustedt, and is very similar to *N. subtilissim* Cleve (cf. Hustedt 1927—1964, Teil 3: 89, F. 1235) It differs, however, from *N. subtilissima* in its dimensions being smaller, and in the arrangement of the striae, bein parallel in the new species instead of radial in the middle It is also reminiscent of *N. subarvensis* Hustedt (l. c. 87, F. 1230), from which it differs in the shape of th valve and the direction of the transapical striae.
N. tenuissima has a linear-lanceolate valve with sma capitate poles, 11.5—16.5 μ long and 2.5—4 μ broac The raphe is straight and filiform with indistinct pola fissures. The axial area is narrow and linear, and doe not widen at the central nodule to form a central are The transapical striae are fine and parallel throughout th valve surface, about 32—36 in the middle and becomin

more dense towards the poles, where they number about 40 in 10 μ.
Figures 165, 166.
Valvae lineari lanceolatae, apicibus protractis et capitulis parvis munitis, 11.5—16.5 μ longae, 2.5—4 μ latae. Rhaphe directa, filiformis, fissuris terminalibus haud visibilibus. Area axialis anguste linearis, neque in media parte dilatata, itaque area centralis nulla. Striae transapicales subtiles, in tota longitudine valvae parallelae, 32—36 in 10 μ in partibus medianis valvae, ad apices versus densior positae, usque ad circiter 40 in 10 μ.
Habitat: in fluvio Kleinvaal River sub ponte viae publicae inter pagos Amersfoort et Wakkerstroom Africae Meridionalis.
Typus: praeparatum no. Vaal 464 in collectione G. S. I. R., Pretoria.
Iconotypus: figurae nostrae no. 165 et 166.
This small species had a wide distribution in the catchment area, being found in a few samples from widely scattered points. It generally occurred as single specimens in the samples, but was sometimes more abundant.
Figures 165, 166.
Samples — 251, 266, 301, 331, 333, 348, 350, 358, 370, 429, 437, 464.

N. terrestris Boye Petersen (cf. Lund 1946: 80, F. 7M—X).
Lund (l. c.) has given a very clear picture of the systematics and taxonomy of this particular species, and pointed out quite clearly that *N. terrestris* has nothing to do with *N. gibbula* Cleve (1894: 140). Cleve apparently missed the longitudinal line near the axial area, and the two projections of the raphe at the central nodule. These features according to Cholnoky (1962a: 48) are quite easily seen at lower powers of magnification and in dry systems. The Vaal specimens were in good agreement with Lund's description of the species.
In the catchment area the species was recorded from three localities, from the Klip River at Stations 11A und 12, and from Station 1 on the Vaal River where the water is constantly acidic.
Samples — 251, 301, 331, 370, 479.

N. towutiensis Cholnoky (1963d: 245, under *N. Woltereckii* var. *rostrata*).
Sample — 492.

N. tridentula Krasske (cf. Hustedt 1927—1964, Teil 3: 82, F. 1223).
Samples — 403, 412, 456.

N. Twymaniana Archibald (1966a: 264, F. 41—43).
Since first described the species the opportunity to observe many more examples has arisen, and it is now possible to define the species more precisely. Since range of variation has been enlarged considerably a more complete description of the species is given below. Schoeman's (1969: 58) specimens fall into this range of variation.
The typical form of *N. Twymaniana* (Figs. 167—169, 173—175) has a lanceolate to rhombic-lanceolate valve, 10—22 μ long and 3—5 μ broad; the poles are rounded and not produced. The raphe is straight and filiform. The axial area is narrow and linear, and does not widen to form a central area. The striation of the valve is variable; the striae are fine, about 27—32 in 10 μ in the middle, where they are parallel; towards the poles they become more dense and are generally invisible under the microscope, i. e. probably numbering more than 40 in 10 μ. In some valves, however, the polar striae are visible and are convergent numbering about 40 or more in 10μ.
Two other valve shapes have been observed and could possibly be considered as form of this species. However at present there is insufficient evidence to describe them as separate forms. The one form with a lanceolate valve having slightly protracted rostrate poles (Fig. 172) was also observed by Schoeman (l. c.: Fig. 76). The other abnormal example has relatively narrower valves which were distinctly rhombic in outline and had acutely rounded poles (Figs. 170, 171).
The autecology of *N. Twymaniana* is at present unknown. It was widespread in the Vaal Dam Catchment Area, and this suggested that it has a preference for alkaline waters. It did not occur abundantly in any of the samples.
Figures 167—175.

N. vanidica Cholnoky (1962a: 49, F. 69, 70).
Sample — 410.

N. variostriata Krasske (cf. Hustedt 1927—1964, Teil 3: 201, F. 1320).
Sample — 317.

N. ventosa Hustedt (1927—1964, Teil 3: 234, F. 1357).
Amongst the typical examples of this species (Figs. 179, 181) there were some specimens showing a series from the typical examples, through a specimen with slightly protracted poles (Fig. 180), to specimens having rhombic-lanceolate valves with acutely rostrate poles (182, 183).
The only previous records of this species from South Africa are Cholnoky's observations from South West Africa (Cholnoky 1966a: 50; 1966b: 198). In the catchment area it was observed in eight samples from scattered localities.
Figures 179—183.
Samples — 242, 321, 324, 401, 410, 449, 455, 511.

N. viridula Kützing (cf. Hustedt 1930: 297, F. 503).
N. viridula has been rarely found in South Africa, and its autecology is little known. In the catchment area it was found as isolated specimens in samples from widely scattered localities.

N. viridula var. *slesvicensis* (Grunow) Cleve (cf. Hustedt 1930: 297).
This variety is smaller in its dimensions and more coarsely striate than the typical forms of the species. In the catchment area it was recorded from four samples collected from a marsh near Ermelo, and from the Kleinvaal, Grootspruit and Sand Rivers.
Samples — 353, 411, 456, 478.

N. Wittrockii (LAGERSTEDT) CLEVE-EULER (cf. HUSTEDT 1927—1964, Teil 3: 124, F. 1256).
Samples — 479, 485.

N. Zanonii HUSTEDT (1949a: 92, T. F. 1—5).
In this series of samples *N. Zanonii* was present in the typical form and was easily distinguished from other related forms.
The species is apparently very common in South Africa, and according to CHOLNOKY (1960a: 87; 1960b: 256; 1962b: 92; 1962c: 330) is a "Characterpflanze" of neutral to weakly alkaline water, poor in organic nitrogen content. Consequently this species was very common and widespread in the catchment area, occurring in some samples in relatively high numbers.

Neidium PFITZER 1871

N. affine (EHRENBERG) CLEVE (cf. HUSTEDT (1930: 242, F. 376).
Samples — 306, 412, 495.

N. affine var. *amphirrhynchus* (EHRENBERG) CLEVE (cf. HUSTEDT 1930: 243, F. 377).
In the catchment area this variety was recorded from a large number of samples, but it was never present in great numbers in any of the samples.

N. affine var. *longiceps* (GREGORY) CLEVE (cf. HUSTEDT 1930: 244, F. 378).
Samples — 233, 251, 327, 328, 330, 332, 359, 434.

N. gracile HUSTEDT f. *aequale* HUSTEDT (1937—1939, Suppl. 15: 406, T. 16, F. 10).
Sample — 485.

N. inconspicuum HUSTEDT (1922b: 149, T. 1, F. 21).
The taxonomic views of CHOLNOKY in regard to this species have been followed. He maintained that *N. inconspicuum* and *N. Hermannii* HUSTEDT (1937—1939, Suppl. 15: 408, T. 16, F. 11) were synonymous. On the other hand PATRICK and REIMER, while noting the similarity between the two species, preferred to retain them as separate taxa on the grounds of a slightly denser striation of the valve surface in *N. inconspicuum* (38 striae in 10 μ instead of 34). The specimen observed in the Vaal Dam Catchment Area (Fig. 184) was slightly unusual in that, while the striae in the middle were visible and numbered 35 in 10 μ, the striae towards the poles gradualy became finer and more densely arranged until resolution was difficult and they became invisible.
Only one example was found in a sample collected from a locality near the source of the Wilge River.
Figure 184.
Sample — 328.

N. iridis (EHRENBERG) CLEVE f. *vernale* REICHELT (cf. HUSTEDT 1930: 245, F. 380).
Sample — 370.

N. iridis var. *amphigomphus* (EHRENBERG) VAN HEURCK (cf. HUSTEDT 1930: 245, F. 382).
Samples — 343, 441.

N. productum (W. SMITH) CLEVE (cf. HUSTEDT 1930: 245, F. 383).
Samples — 325, 485.

Nitzschia HASSALL 1845.

N. accomodata HUSTEDT (1949a: 139, T. 12, F. 27—31, 34, 35).
This *Nitzschia* species is very similar to *N. palea* (KÜTZING) W. SMITH, differing from it in the coarser structure of the valve, which makes the resolution of the transapical striae easier. For this reasons CHOLNOKY (1956: 81; 1957a: 71; 1958a: 126) claims that it is very often mistaken for *N. palea*. CHOLNOKY's observation of this species has greatly increased the range of variability of the species. He has found the length of the species to vary between 22—44 μ (CHOLNOKY 1956: 81; 1958b: 126), and the number of striae in 10 μ to vary between 32 and 38 (CHOLNOKY 1960a: 90).
N. accomodata, in its typical form, was relatively widespread in the catchment area, although it was never found in very large numbers in the samples.

N. acicularis (KÜTZING) W. SMITH (cf. HUSTEDT 1930: 423, F. 821).
This species has until recently been incorrectly ascribed solely to W. SMITH. However, according to DE TONI (1891: 549) KÜTZING described this species under the genus SYNEDRA, and it was then later transferred to the genus *Nitzschia* by W. SMITH in 1853. Most of the specimens found in the catchment area were typical examples, but there were a few (e. g. Fig. 185) which supported CHOLNOKY's observation of much smaller forms. CHOLNOKY originally described these smaller examples as a new variety, var. *africana* (CHOLNOKY 1957a: 72) but has subsequently found taht there are intermediate forms linking the variety with the typical forms of the species (CHOLNOKY 1962b: 93).
N. acicularis is a nitrogen heterotrophic, planktonic diatom species inhabiting still standing or sluggishly flowing parts of the rivers (CHOLNOKY 1962b: 93; 1966b: 199). In the catchment area during the dry season, conditions approaching those suitable for this species can be obtained. This is probably the reason for its widespread distribution in the catchment area. It did not however, occur in large numbers.
Figure 185.

N. acula HANTSCH (cf. HUSTEDT 1930: 423, F. 821).
The species has been seldom recorded from South Africa and in the catchment area it was observed in one sampl[e] from Station 19 on the Kaffirspruit River.
Sample — 343.

N. adapta HUSTEDT (1949a: 135, T. 12, F. 3—6).
CHOLNOKY (1956: 81; 1957a: 72) recorded specimen[s] having much smaller dimensions than those cited b[y] HUSTEDT (l. c.), and gave the following measurements — length 65—85 μ, breadth 3—3.5 μ, carinal pore[s] 13—16 in 10 μ and transapical striae 33 — over 44 i[n] 10 μ. Most of the specimens observed in the catchmen[t]

area agreed with CHOLNOKY's dimensions although some were even smaller. The Vaal specimens ranged from 47—86 μ long, about 3 μ broad and generally had 14 carinal pores and 36 striae in 10 μ. The smaller examples intergrade with the larger forms.
This species has been recorded mainly from Natal, with further observations from the Okawango River and the Hog's Back Region in the Eastern Cape Province. In the catchment area it was one of the most common species, although it was never found in great abundance in any sample. The autecology of this species is still unknown.

N. Agnewii CHOLNOKY (1962b: 94, F. 18, 19).
This small species of *Nitzschia*, described by CHOLNOKY from the Eastern Transvaal, can easily be overlooked due to its small size and weakly silicified valve walls. In general the typical forms of the species were observed in the catchment area. An atypical example whose identity is doubtful has been illustrated in figure 186. This specimen agreed morphologically with CHOLNOKY's description, but it was much larger, being 25 μ long and 2.5 μ broad. It differed also in the number of carinal pores, having 13 in 10 μ instead of 16—19. It was not, however, considered to be *N. agnita* HUSTEDT on account of its weakly silicified cell walls and smaller dimensions, and has therefore been included with this species.
The only previous record of this species is from its type locality in the Eastern Transvaal. It was recorded from a few samples from the catchment area as isolated specimens. Nothing is known of its autecology.
Figure 186.
Samples — 316, 322, 324, 339, 344, 408, 410, 465, 512, 552.

N. agnita HUSTEDT (1957: 347, F. 51).
Samples — 340, 353, 377, 401, 412, 493.

N. allansonii CHOLNOKY (1958a: 257, F. 24—27).
Sample — 401.

N. amphibia GRUNOW (cf. HUSTEDT 1930: 414, F. 793).
Some abnormally large specimens of this species were reported by CHOLNOKY (1963a: 35) from Windhoek; these specimens were 65 μ long and 6 μ broad and intergraded with the typical forms. At the other extreme some very short lanceolate valves with protracted poles were recorded from Lake Sibayi (ARCHIBALD 1966b: 491); these small specimens measured only 9.5 μ in length. From CHOLNOKY's observations *N. amphibia* is a nitrogen heterotrophic species having a pH optimum above pH 8.0, and on account of its relatively high permeability can tolerate a fairly high salt concentration. The species was recorded from a large number of samples from the catchment area, mainly from the Waterval River.

N. amphioxoides HUSTEDT (1949a: 140, T. 13, F. 65—72).
N. amphioxoides is one of the less common species of this genus to be found in South Africa. CHOLNOKY has recorded it from the Cape Province (1959: 55), Lake Chrissie (1965: 74) and the Okawango River (1966a: 54). In the Vaal Dam Catchment Area it was found over a wide area in scattered localities, but was never observed in large numbers. The autecology of this species is not known.

N. angustata (W. SMITH) GRUNOW (cf. HUSTEDT 1930: 402, F. 767).
CHOLNOKY (1961: 314) maintained that it was impossible to separate *N. angustata* from its variety var. *acuta*, although he gave no reasons for this statement. Among the few specimens of both the typical and the varietal forms of this species found in the catchment area there was no evidence for any transitional forms linking the two forms. HUSTEDT's (1930: 402) systematic treatment of the species has therefore been followed. This species was recorded from a small tributary of the Kaffirspruit River.
Sample — 491.

N. angustata var. *acuta* GRUNOW (cf. HUSTEDT 1930: 402, F. 768).
Samples — 309, 342, 344, 427, 429, 493.

N. angustecarinata HUSTEDT (1952b: 126, F. 62).
Having recently received HUSTEDT's report on the diatoms collected in Venezuela by a German limnological expedition (HUSTEDT l. c.), it was discovered that *N. crassepunctata* ARCHIBALD (1966a: 266, F. 49) is synonymous with *N. angustecarinata*. The specimen from the catchment area differed slightly from HUSTEDT's diagnosis, being slightly shorter and narrower than HUSTEDT's examples. The Vaal specimen (Fig. 196) was 48.5 μ long and 4.5 μ broad, and had 40 transapical striae in 10 μ. Since HUSTEDT observed only a few specimens the full range of variation was not known, and these measurements extend the known range of variability of the species.
A single specimen, constituting the first record of this species for South Africa, was recorded at Villiers on the Vaal River (Station 6).
Figure 196.
Sample — 403.

N. apiculata (GREGORY) GRUNOW (cf. HUSTEDT 1930: 401, F. 765).
HUSTEDT (l. c.) regarded this species as a salt water form, often found in inland brackish waters. However, CHOLNOKY (1960a: 91) remarked that the distribution of this species was limited by its sensitivity to the pH value of the water and not by its sensitivity to the osmotic pressure. It appears therfore that this species inhabits waters having a high concentration of dissolved salts and an alkaline pH value. In the catchment area, the Waterval River appeared to have a slightly raised concentration of dissolved salts, and the species was recorded mainly from this river. It was also recorded from about four other localities.

N. bacata HUSTEDT (1937—1939, Suppl. **15**: 485, T. 41, F. 30—33).
This species has been recorded from many localities in South Africa. In the catchment area, however, it was

rare, being recorded in small numbers from a relatively small number of samples.

N. capitellata HUSTEDT (1930: 414, F. 792).
The specimens of this species were generally the typical forms. There were some examples which were rather shorter than normal, and one of these (25 μ long) has been illustrated (Fig. 187).
N. capitellata is a nitrogen heterotrophic species preferring relatively alkaline waters with large concentrations of organic nitrogenous materials (CHOLNOKY 1962a: 52; 1962b: 95). This species has been found to be not particularly tolerent of the presence of large concentrations of dissolved salts. In the catchment area the species was reasonably common over a widespread area, and in some samples it was recorded in relatively high numbers.
Figure 187.

N. Chasei CHOLNOKY (1954b: 220, F. 98).
In the type material CHOLNOKY (l. c.) was unable to determine how many carinal pores were present in 10 μ in this species, and came to the conclusion that they appeared to be the same in number as the transapical striae, but did not correspond with the striae because of their irregular spacing. It was only later that CHOLNOKY (1960a: 91) was able to ascertain that there were in fact 10 carinal pores in 10 μ. The specimens from the catchment area agreed with CHOLNOKY's description of the species, and the same difficulties were experienced in regard to the number of the carinal pores. In some specimens the number of carinal pores were difficult to determine and appeared to be the same as the number of transapical striae (Fig. 190), while in others the carinal pores were more readily resolved, and numbered between 8 and 10 in 10μ (Figs. 188, 189, 191). The specimens recorded from the catchment area enabled the range of variability to be enlarged furthermore; the dimensions of these specimens were 7—12 μ long, 2—2.5 μ broad and has 16—20 transapical striae in 10 μ. A doubtful specimen (Fig. 192) has been assigned to this species on account of its similarity, but the striation was denser than the typical forms, and the number of the carinal pores were difficult to resolve.
The species was quite common in the catchment area and in some samples was present in relatively large numbers.
Figures 188—192.

N. Chutteri ARCHIBALD (1966a: 265, F. 47, 48).
This *Nitzschia* species was recorded from Stations 15 and 16 on the Kalk River, and from a small stream near Villiers. It composed 8% of the diatom association at Station 15. This may suggest some tolerance of this species to dissolved salts as the Total Dissolved Solids (TDS) value for the Kalk River was higher than elsewhere in the catchment area.
Figures 193, 194.
Samples — 401, 402, 404.

N. Clausii HANTZSCH (cf. HUSTEDT 1930: 421, F. 814).
In the past this species has been related to *N. sigma* W. SMITH (cf. HUSTEDT l. c.: 420, F. 813). More recent opinions have regarded this as not feasible as the structure of the keels differ in the two species. *N. Clausii* has a keel which is slightly sunken in the middle indicating a central nodule, while the keel of *N. sigma* does not posses this feature. In the Sunda Islands material HUSTEDT (1937—1939, Suppl. **15**: 488) recorded some specimens of *N. Clausii* without this depression of the keel and claimed this as evidence for the reduction of the central nodule in this species. All the specimens observed in the catchment area possessed a sunken keel. Amongst these examples some unusual forms were found having almost completely linear valves with only the poles curving in opposite directions (Fig. 195).
In contradiction to HUSTEDT's views (HUSTEDT l. c.) CHOLNOKY has found this species in fresh alkaline water (CHOLNOKY 1957a: 74; 1960a: 92), and he maintained that the species was nitrogen heterotrophic (CHOLNOKY 1962b: 95). Supporting CHOLNOKY, the species is relatively common in the alkaline waters of the catchment area, and sometimes occurred in large numbers. It was widespread in distribution.
Figure 195.

N. communis RABENHORST (cf. HUSTEDT 1930: 417, F. 798).
Samples — 245, 312, 334, 342, 413, 433, 493.

N. commutata GRUNOW (cf. HUSTEDT 1930: 405, F. 774).
Sample — 412.

N. confinis HUSTEDT (1949a: 145, T. 11, F. 49—54; T. 13, F. 84—90).
This species is a nitrogen heterotrophic *Nitzschia* found commonly in neutral waters in South Africa (CHOLNOKY 1956: 83; 1962b: 95), and was found by HUSTEDT (l. c.) to be extremely common in the plankton of the Congo lakes. In the catchment area it had a widespread distribution and at some sampling sites was relatively abundant.

N. debilis (ARNOTT) GRUNOW (cf. HUSTEDT 1930: 400, F. 759).
Samples — 417, 430.

N. demota nom. nov. (ARCHIBALD 1966c: 230, F. 7, under *N. exilis* n. sp.).
Since the combination *N. exilis* has already been used by SOVEREIGN (1958: 131, Pl. IV, F. 78) a new sepcific epithet is required for this species. *N. demota* has therefore been proposed. Since the publication of the original description of this species further examples have been examined, and a more precise definition of the species is possible. *N. demota* is long and narrowly linear with gradually tapering ends, the poles being regularly and sharply rounded but not capitate, 82—102 μ long, and 1.5—2 μ broad. The keel is excentric and has 12—16 (generally 14) carinal pores in 10 μ, of which the central two are not more widely spaced than the others. The transapical striae are too fine to be seen under the light microscope. The valve walls are relatively well silicified.
Figures 201, 202.

The species was rare in the catchment area and was recorded from only seven samples.
Figures 201, 202.
Samples — 266, 306, 312, 315, 336, 410, 431.

N. diluta ARCHIBALD (1966a: 266, F. 50).
Since first describing the species a further four examples have been examined, resulting in the enlargement of the range of variation of the species. No change was found in the valve shape but the dimensions of the valve have been altered. The length ranges between 37 and 51 μ, and the breadth between 3 and 4 μ. The number of carinal pores vary between 13 and 14, and the transapical striae have a range of 33—36 in 10 μ.

N. diluta was recorded from four localities in the catchment area, from a stream near Villiers, Station 19 on the Kaffirspruit, from a sample collected in the Witzieshoek district and from samples collected near the source of the Russespruit River.
Figures 197, 198.
Samples — 203, 249, 405, 493.

N. diserta HUSTEDT (1949a: 139, T. 12, F. 32, 33).
Figures 199 and 200 illustrated examples of this species, which, while agreeing morphologically with HUSTEDT's description of the species, were very much smaller in size. These smaller forms were connected to the lower limits of HUSTEDT's dimensions from the Congo specimens by a series of intergrading forms. The dimensions of the Vaal specimens ranged from 21—39 μ in length, 3.5—4.5 μ in breadth, and had 12—16 carinal pores and 36—40 transapical striae in 10 μ.
Outside the Congo, the type locality of the species, *N. diserta* has only been recorded from the Waterberg area in the Transvaal (CHOLNOKY 1958b: 128). It was recorded from a few samples collected from four localities in the catchment area.
Figures 199, 200.
Samples — 313, 377, 417, 489, 493.

N. dissipata (KÜTZING) GRUNOW (cf. HUSTEDT 1930: 412, F. 789).
According to CHOLNOKY (1962b: 95) *N. dissipata* is nitrogen autotrophic and inhabits well oxygenated slightly alkaline water. To a certain degree such conditions are found all over the catchment area, resulting in a widespread distribution of the species in the region. It was, however, generally found in small numbers, indicating that optimal conditions for its reproduction were seldom experienced.

N. elliptica HUSTEDT var. *alexandrina* CHOLNOKY (1958a: 258, F. 29, 30).
Samples — 377, 402, 438, 489, 497.

N. epiphytica O. MÜLLER (cf. HUSTEDT 1949a: 143, T. 13, F. 56—64).
Samples — 412, 414, 464, 497.

N. epiphyticoides HUSTEDT (1949a: 144, T. 13, F. 48—55).
Samples — 375, 401, 410, 411, 412, 417, 468.

N. fonticola GRUNOW (cf. HUSTEDT 1930: 415, F. 800).
According to HUSTEDT (1949a: 142, T. 11, F. 75—83, 91—93) and CHOLNOKY (1959: 56) *N. fonticola* is extremely variable in its morphology, and the numerous examples from the catchment area have confirmed this. In the sample Vaal 498 this great variability was well illustrated, showing extremely small examples intergrading with the more typical forms of the species (Figs. 203—208). The smallest specimens in this series measured 5 μ long and 3.5 μ broad. Due to the irregular spacing of the carinal pores of these small forms, some examples were very similar to *N. epiphytica* O. MÜLLER since they sometimes appeared to have the two central pores more widely spaced than the others.
For its optimal development, N. fonticola requires a relatively high concentration of organic nitrogenous compounds in solution and pH value of the water of about pH 8 (CHOLNOKY 1960b: 258; 1962a: 54; 1962b: 96); furthermore it requires a relatively high oxygen content of the water (CHOLNOKY 1966b: 202). *N. fonticola* was widely distributed in the catchment area and was sometimes present with high relative densities, indicating that its ecological requirements were often fulfilled. This species in association with other nitrogen heterotrophic *Nitzschiae* was one of the most common species in the more eu- and mesotrophic waters of the region.
Figures 203—208.

N. frustulum (KÜTZING) GRUNOW (cf. HUSTEDT 1930: 414, F. 795).
N. frustulum is a brackish water species (CHOLNOKY 1962a: 55; 1966b: 202) and was found in small numbers in two samples from the Kalk River, one from the Grootvlei Dam which received mineralised waters from the Springfield Colliery, and the other from lower down the river (Station 15).
Samples — 401, 402.

N. gracilis HANTZSCH (cf. HUSTEDT 1930: 416, F. 794).
N. gracilis (Fig. 209) was recorded from a relatively large number of samples, distributed widely over the catchment area, but never attained large numbers in any of them.
Figure 209.

N. hungarica GRUNOW (cf. HUSTEDT 1930: 401, F. 766).
This species is a brackish water form requiring alkaline water for good development, and is nitrogen autotrophic in character (CHOLNOKY 1960b: 260; 1966b: 202). Due to the fresh water nature of the rivers in the catchment area this species was found in small numbers over a wide area of the region, and in only two samples was recorded as relatively abundant, forming 6.6% of the association in sample Vaal 485 and 4.5% of the association in Vaal 245.

N. intermedia HANTZSCH (cf. HUSTEDT 1949a: 136, T. 12, F. 21—23).
HUSTEDT (1937—1939, Suppl. **15**: 477; 1949a: 136) has commented in detail on the systematics of this species,

showing that its variable nature is to a degree dependent on the locality in which it was found. CHOLNOKY (1936c: 188) has reported some abnormally short specimens only 52 μ long, and many of the examples observed in the catchment area agreed with this, the smallest being 52.2 μ long. These short specimens were also finer in structure having 12 carinal pores and 24—30 transapical striae in 10 μ.
Only two specimens were recorded from the Waterval River.
Samples — 325, 410.

N. intermissa HUSTEDT (1949a: 136, T. 12, F. 11 14).
There is some doubt whether all the specimens recorded under this species did in fact belong to *N. intermissa*, since in the earlier parts of this survey it might have been confused with *N. adapta* HUSTEDT.
The only records of this species were made from the Waterval River, where it was never common.
Samples — 321, 322, 323, 337, 403, 405, 406, 408, 410, 411, 412.

N. interrupta (REICHELT) HUSTEDT (cf. HUSTEDT 1927: 168).
CHOLNOKY (1960b: 260) regarded this species as an indicator species of neutral to weakly alkaline, oligotrophic waters, and commented further that it was nitrogen autotrophic and unable to tolerate poorly oxygenated water, or water with a raised osmotic pressure (CHOLNOKY 1966b: 203). In the catchment area the species was widely distributed over the whole region, and particularly in the Vaal and Waterval Rivers. In most cases *N. interrupta* occurred in relatively high numbers in diatom associations, having the *Cymbella* species (particularly *C. amphicephala* NAEGELI, *C. microcephala* KÜTZING and *C. Kappii* CHOLNOKY) as the dominant species in the association. In such associations it was quite often accompanied by high numbers of *N. linearis* W. SMITH.

N. irremissa CHOLNOKY (1959: 57, F. 298—300).
Sample — 350.

N. Kuetzingiana HILSE (cf. HUSTEDT 1930: 416, F. 802).
In his report on the diatom material from the Sunda Islands HUSTEDT (1937—1939, Suppl. **15**: 483) stated that the main difference between this species and *N. palea* (KÜTZING) W. SMITH was the lanceolate valve shape of *N. Kuetzingiana*. However, in the catchment area the shape of the valve in this species was extremely variable (see Figs. 210—213). In this study *N. palea* and. *N. Kuetzingiana* were best distinguished on the basis of the structure and number of the carinal pores. In *N. palea* the carinal pores are characteristically transapically elongated and number between 10 and 14 in 10 μ, while in *N. Kuetzingiana* the carinal pores are never elongated and number between 13 and 16 in 10 μ.
The species is strongly nitrogen heterotrophic with pH optimum around 7.6—7.8 μ, and it thrives in oxygen rich waters (CHOLNOKY 1966b: 203). Together with other nitrogen heterotrophic *Nitzschiae* this species was found in high numbers at the sampling points where the concentration of the organic nitrogenous materials in the water was high. At other sampling points the species was present but never in large numbers.
Figures 210—213.

N. lauenburgiana HUSTEDT (1946—1950: 402, T. 40, F. 6, 7, 9—11).
The details of the single specimen of this species (Fig. 214) have been given in an earlier publication (ARCHIBALD 1966c, 232, F. 19). This was the first record of *lauenbergiana* HUSTEDT for South Africa.
Figure 214.
Sample — 411.

N. levidensis (W. SMITH) GRUNOW (cf. HUSTEDT 1930: 399, F. 760, under *N. tryblionella* var. *levidensis*).
N. levidensis is an alkaline water form. In the catchment area it was present in a number of samples but never in large numbers.

N. levidensis var. *victoriae* (GRUNOW) CHOLNOKY (1966a: 57).
The variety is not common in South Africa, and CHOLNOKY (1962b: 100) claimed that it is nitrogen autotrophic having a pH optimum value of over pH 8.0. In the catchment area the variety occurred as isolated examples in a number of samples.

N. linearis (AGARDH) W. SMITH (cf. HUSTEDT 1930: 409, F. 784).
Amongst the many typical forms of this species a few unusally short specimens were observed, and one of these (50 μ in length) has been illustrated (Fig. 215).
N. linearis is apparently nitrogen autotrophic, having a pH optimum in the region of pH 8.0 (CHOLNOKY 1962b: 97; 1966b: 204), and is found in well aerated waters. The species was very common in the catchment area and was distributed over the whole region. It was found in most samples, and in some attaining very high numbers; in the samples Vaal 329 (64.2%) and Vaal 431 (63.9%) it was the dominant species in the diatom associations.
Figure 215.

N. mediocris HUSTEDT (1949a: 149, T. 13, F. 21—24).
The species (Fig. 216) was rare in the catchment area, being recorded in few samples.
Figure 216.
Samples — 245, 251, 253, 324, 330, 331, 333, 353, 411, 478.

N. microcephala GRUNOW (cf. HUSTEDT 1930: 414, F. 791).
According to CHOLNOKY (1960b: 261) this small and easily recognisable species thrives in waters with a high pH value and can tolerate a high osmotic pressure. It is also, like so many other species of its group, nitrogen heterotrophic. In the Vaal Dam Catchment Area it was reasonably widely distributed over the whole region, but was not common in any of the samples.

N. obligata ARCHIBALD (1966c: 233, F. 20).
Examination of examples from a further three samples makes it possible to extend the range of variability of the

species, thus making the definition of the species more precise. The species varies in length from 30.5—45 μ long, and in width from 2.5—3 μ. The carinal pores numbered from 14—16 in 10 μ, while the number of transapical striae still remain undetermined as they are invisible unter the microscope.
The species was recorded in the catchment area from Stations 2a, 4, 17 and 20, but at none of these stations was it present in large numbers.
Figures 217, 218.
Samples — 307, 412, 417, 463.

N. obsidialis HUSTEDT (1949a: 148, T. 13, F. 25).
N. obsidialis has a superficial similarity to the previous species, but differs from it in its more widely spaced carinal pores. An unusual form showing visible striation of the valve surface (about 40 striae in 10 μ) was included with *N. obsidialis* since it showed great similarities to this species and could not be associated with any other *Nitzschia* known to the author.
Two specimens were seen in the catchment area, one from a small stream near Standerton and the other from Lake Chrissie.
Figure 219.
Samples — 415, 485.

N. obsoleta HUSTEDT (1949a: 146, T. 13, F. 94—99).
Samples — 479, 485.

N. Oliffii CHOLNOKY (1956: 84, F. 116, 117).
In most cases the typical forms of the species were observed, although in one example the carinal pores were spaced more closely together (about 8 in 10 μ).
CHOLNOKY (1962b: 97) maintained that *N. Oliffii* is apparently associated with high pH values and is nitrogen autotrophic. The observations in this regard from the catchment area appeared to support CHOLNOKY's findings, since all the samples containing this species appeared to contain little organic nitrogen in solution.
Samples — 306, 309, 312, 322.

N. palea (KÜTZING) W. SMITH (cf. HUSTEDT 1930: 416, F. 801).
While LUND (1946: 102) stated that he had observed 30—36 striae in 10 μ and only occasionally were the striae invisible, CHOLNOKY found that in most cases the striation of the valve in *N. palea* was invisible under the light micrsocope. In the catchment area it was unusual to detect the striation of the valve surface of this species as it was in most cases invisible. Three abnormal valves were observed, one with visible striae (Fig. 222) and the other two with abnormally shaped valves (Figs. 220, 221)
N. palea is one of the most important indicator species of water carrying large quantities of organic nitrogenous material (CHOLNOKY 1962b: 98; 1966b: 205). CHOLNOKY (l. c.) maintained that *N. palea* is strongly nitrogen heterotrophic preferring alkaline water (pH optimum around pH 8.0) having a high oxygen concentration. *N. palea* will therefore be found in very large numbers wherever there is strongly flowing water contaning a high concentration of organic nitrogen. In the Vaal Dam Catchment Area *N. palea* was present in nearly every sample, generally in low numbers and occasionally in very significant numbers. In the samples Vaal 417 (82.2%) and Vaal 497 (83,8%) it was the dominant species in the association.
Figures 220—222.

N. parvula LEWIS (cf. HUSTEDT 1930: 421, F. 816).
Samples — 301, 307, 328, 350, 370.

N. parvuloides CHOLNOKY (1955b: 179, F. 72, 73).
Samples — 249, 301, 327, 330, 370, 479, 485, 486, 553.

N. perminuta GRUNOW (cf. HUSTEDT 1930: 415, under *N. frustulum* var. *perminuta*).
This species is morphologically very variable, and CHOLNOKY (1957a: 75) has reported a series of examples in which some show an irregular arrangement of the carinal pores. Amongst the normal arrangement there were some which had central pores more widely spaced than the others; these abnormal forms did, however, intergrade with the typical arrangement of the carinal pores. A similar set of specimens (Figs. 224, 225) were sometimes found amongst the normal (Fig. 223).
N. perminuta is a nitrogen heterotrophic species found in neutral to weakly alkaline waters (pH optimum about pH 7.6), but is occasionally found where the pH value of the water fluctuates to the acid side (CHOLNOKY 1960b: 262; 1962b: 98; 1966b: 206). In the catchment area the species was found in nearly all the samples, although generally in low numbers and sometimes as a single record. However, at some sampling points, where the organic nitrogen cencentration was fairly high, relatively high numbers of this species were recorded.
Figures 223—225.

N. perpusilla RABENHORST (cf. HUSTEDT 1930: 415, under *N. frustulum* var. *perpusilla*).
Although there are many contrasting opinions concerning the systematic position of this species and *N. frustulum* (CHOLNOKY 1960b: 258; 1962a: 55; 1962b: 96; 1966b: 202; 1966c: 167), *N. perpusilla* has been considered in this survey as a separate species on ecological grounds. Some of the smaller forms of this species were very similar in appearance to *N. epiphyticoides* HUSTEDT, and can easily be confused with this species (Figs. 226, 227).

N. perpusilla is a freshwater species which is nitrogen heterotrophic and inhabits alkaline waters. It was recorded from a large number of localities in the catchment area, but was never abundant in any of the samples.
Figures 226, 227.

N. perspicua CHOLNOKY (1960b: 262, F. 36).
In a recently received paper SOVEREIGN (1963: 365) described a species of *Nitzschia* using the same epithet. This epithet "*perspicua*" was preoccupied by CHOLNOKY (l. c.) three years earlier. This necessitates a change in the name of SOVEREIGN's species. No name will be proposed here as it is unknown whether such a change has

already taken place or not. An example of CHOLNOKY's species has been illustrated in Figure 228.

This very rare species has been recorded from the type locality (CHOLNOKY 1960b: 262) and from three samples collected in the catchment area.

Figure 228.

Samples — 239, 377, 413.

N. proxima HUSTEDT (1955b: 46, T. 16, F. 13).

CHOLNOKY (1959: 58) reported specimens with smaller dimensions than those given by HUSTEDT (l. c.) in his original description. The examples (Fig. 229) from the catchment area agreed more with CHOLNOKY's measurements.

In the catchment area it was recorded from two small tributaries of the Waterval River.

Figure 229.

Samples — 405, 411.

N. pseudobacata CHOLNOKY (1958b: 129, F. 130, 131).

Samples — 306, 485.

N. Rautenbachiae CHOLNOKY (1957a: 76, F. 228—232).

N. Rautenbachiae has been recorded from Natal and the Cape Province, where CHOLNOKY (1960a: 102) maintained it to be widespread in the waters of the coastal rivers. Furthermore, in a recent personal communication CHOLNOKY claimed that it was a marine or brackish water form. For this reason it was surprising to find this species to be fairly widespread in the fresh waters of the catchment area. It was, however, present in significant numbers in only two samples (Vaal 419 — 17.9% and Vaal 447 — 7.8%).

N. recta HANTZSCH (cf. HUSTEDT 1930: 411, F. 785).

Samples — 307, 411.

N. romana GRUNOW (cf. HUSTEDT 1930: 415, F. 799).

Sample Vaal 409, rich in specimens of *N. romana*, provided evidence for a wide range of variability in this species, and a series of drawings has been made to illustrate this (Figs. 230—236). The valves range from linear to lanceolate in shape; the small linear forms have conical and slightly protracted poles and are sometimes slightly capitate (Figs. 231, 232, 235); the more lanceolate forms either taper gradually to acute slightly capitate ends, or are conically protracted (Figs. 230, 234, 236). Furthermore, in another sample a rather irregularly shaped valve of *N. romana*, having a median constriction, was observed (Fig. 233).

It does not appear that this species is particularly common in South Africa. It was widely distributed over the catchment area, and in some samples it was relatively abundant in its occurrence. *N. romana* was usually also found commonly in association with *N. palea* and *N. perminuta*, and is therefore probably nitrogen heterotrophic.

Figures 230—236.

N. rufitorrentis CHOLNOKY (1960a: 103, F. 308).

The specimens from the Vaal Dam Catchment Area all fell within the length limits, 35—46 μ long, but one or two specimens had slightly narrower valves than the dimensions given in the description of the species. The Vaal specimens were 4.5 μ broad (Fig. 237).

The distribution of this species in South Africa appears to be quite widespread, since CHOLNOKY has found it in Natal (l. c.), the Cape Province (1962a: 59) and the Eastern Transvaal (1962b: 98). In the catchment area it was recorded from the Grootspruit, Klip, Wilge and Holspruit Rivers.

Figure 237.

Samples — 253, 334, 359, 411, 434.

N. sigma (KÜTZING) W. SMITH (cf. HUSTEDT 1930: 420, F. 813).

HUSTEDT (1937—1939, Suppl. **15**: 486; 1949a: 152) maintained that *N. sigma* is a brackish water form, sometimes found in inland waters containing high salt concentrations. The species was rare in the catchment area, but forms 6.6% of the diatom association found in the Springfield Colliery Dam, which is known to be highly mineralised (MALAN 1960: 27;) and at Station 7 on the Waterval River where the water also appeared to have slightly higher concentrations of dissolved salts than elsewhere in the catchment area, it composed 5.4% of the association.

N. sigma var. *fonticola* HUSTEDT (1937—1939, Suppl. **15**: 486, T. 40, F. 16, 17).

HUSTEDT (l. c.) regarded this variety as provisionally endemic to the Sunda Islands. However, the records of this species from South Africa (CHOLNOKY 1959: 59) and from three localities in the catchment area show that the species is more widely distributed than was a first thought.

Samples — 233, 421, 554.

N. silica ARCHIBALD (1966c: 234, F. 22—24).

A large number of specimens of this species have been observed since it was first described, and its dimensions have been greatly altered. The species showed a range of valve shape from the large linear valves, having a central portion with parallel walls and relatively long acutely cuneate poles, to the smaller lanceolate forms with protracted but not cuneate ands, which are sometime slightly capitate. The valves ranged in length betwee 13 and 29.5 μ, and were approximately 2 μ wide. Th remaining characteristics were unchanged by the ob servation of the later specimens.

Figures 238—243.

This species was found at scattered localities in the catch ment area and generally in low numbers. However, Station 8 on the Sand River the species compose 24.6% of the diatom association, and at Station 16, t Grootvlei Dam, it composed 2.4% of the associatio The autecology of this species is, however, unknow and therefore no conclusions can be drawn from t relative densities of this species at these two stations.

Figures 238—243.

Samples — 239, 326, 336, 401, 436.

N. siliqua ARCHIBALD (1966a: 267, F. 62).

A few more examples of this species have been obser since it was first described. These observations show

that there was a greater variation in the length of the valve, and the dimensions for this character vary between 18 and 23.5 μ long. The examination of further specimens showed that while the carinal pores are difficult to distinguish in most cases, there were specimens in which they were quite clear; and these confirmed the assumption that they were the same in number as the transapical striae, i. e. 16 in 10 μ. A specimen (Fig. 245) has been included with this species, but on account of its very much coarser striation and smaller density of the carinal pores (in both cases 12 in 10 μ) it is uncertain whether it belongs to this species or not.
N. siliqua was rare in the catchment area, and was generally present as isolated examples in a few samples.
Figures 244, 245.
Samples — 340, 344, 402, 493, 511, 513.

N. spiculoides Hustedt (1949a: 151, T. 13, F. 5, 6).
Two specimens, conforming in most details with Hustedt's description but differing in the structure of the valve wall, were assigned to this species. In these two specimens the striation of the valve surface, although difficult to resolve, was nevertheless visible and numbered about 40 striae in 10 μ. One of these valves has been illustrated (Fig. 246).
The two specimens were recorded from samples collected from the Waterval and Kleinvaal Rivers.
Figure 246.
Samples — 356, 498.

N. spiculum Hustedt (1949a: 150, T. 13, F. 1—4).
In the early part of this survey certain specimens, similar to *N. acicularis* (Kützing) W. Smith, were described as *N. acicularioides* n. sp. (Archibald 1966c: 229, F. 2—4). These specimens differed from *N. acicularis* by their widely spaced central carinal pores. However, after the examination of further material, and in particular the specimens from sample Vaal 242, it became clear that there was a series of forms (Figs. 247—254) linking *N. acicularioides* Archibald with the larger *N. spiculum* Hustedt. *N. aciucularioides* therefore falls away and becomes a synonym of *N. spiculum*. With its incorporation the range of variation of *N. spiculum* has been greatly increased and now reads as follows: — length 37—100 μ, breadth 1.5—2.5 μ and carinal pores 14—18 in 10 μ.
N. spiculum was fairly well distributed over the catchment area, but seldom in high numbers. Nevertheless, in a small tributary of the As River (Vaal 242) it composed 33.2% of the diatom association, and in a headwaters tributary of the Kleinvaal River it composed 54.6% of the association. As the information about the chemical and physical conditions at these two widely spaced points is insufficient, it is not possible to comment on the autecology of this species.
Figures 247—254.

N. stricta Hustedt (1949a: 136, T. 12, F. 9, 10).
By comparing the descriptions of N. *stricta* and *N. pilum* Hustedt (1957: 353) it appears that Hustedt has described the same species twice from different localities. In the author's opinion these two species are identical and should be united. Following the rules of priority the oldest valid name, *N. stricta*, should be adopted, and *N. pilum*, as a result, becomes a synonym.
N. stricta was rare in the catchment area, occurring in small numbers in a number of samples.
Figure 255.

N. subacicularis Hustedt (1937—1939, Suppl. **15**: 490, T. 41, F. 12).
Examples of this species from the catchment area conformed more with Hustedt's orignial description and illustrations (Hustedt l. c.) than with the more recent illustration of this species in his Congo paper (Hustedt 1949a: 150, T. 11, F. 61). Amongst the normal forms of this species a few specimens were found having greater dimensions than those given by Hustedt. One such form, length 62.5 μ and width 3 μ, has been illustrated (Fig. 256).
Hustedt (1957: 357) maintained that this species was "Oligosaprob", implying that the species prefers waters with low concentrations of organic nitrogen. Cholnoky (1962b: 99) on the other hand strongly disagreed on this point, claiming that he had observed this species at many sampling points containing large quantities of organic nitrogen. Observations obtained in the catchment area study do not clarify this point as the species was recorded in low numbers from a few samples from the Waterval and Vaal River System.
Figure 256.
Samples — 321, 324, 348, 350, 404, 408, 410, 411, 513.

N. subvitrea Hustedt (1937—1939, Suppl. **15**: 471, T. 40, F. 12).
Cholnoky (1966a: 59) maintained that the illustrations of this species from Hustedt's Tibet material (Hustedt 1922a) showed only 28 transapical striae in 10 μ, while the specimens from the Sunda Islands (Hustedt 1937 to 1939, Suppl. **15**: T. 40, F. 12) appeared to have 38 striae in 10 μ. The Vaal specimens seemed to be intermediates since the number of striae ranged between 30 and 36 striae. An abnormal form (Fig. 258) with a curved valve has been illustrated as a comparison with a more typical example (Fig. 257.)
In both South Africa and the catchment area this species is rare. It was recorded from five localities scattered over the catchment area.
Figures 257, 258.
Samples — 238, 344, 410, 415, 447.

N. tarda Hustedt (1949a: 138, T. 12, F. 24, 25 and 26?).
The number of transapical striae in the Vaal examples of this species generally fell into the range, 28—30. Occasionally, however, a few specimens were observed having a more densely striated valve surface (32 striae in 10); these more densely striated examples agreed with Cholnoky's observations from the Lake Chrissie area (Cholnoky 1965: 74). Cholnoky regarded these specimens as transitional forms between this species and *N. capitellata* Hustedt.

In the relatively alkaline waters of the catchment area this species was found in a relatively large number of localities, but never in great abundance.

N. thermalis (EHRENBERG) AUERSWALD (cf. HUSTEDT 1930: 403, F. 771).

N. thermalis is a species characteristic of water containing high concentrations of nitrogenous compounds and a low oxygen content (CHOLNOKY 1960b: 263; 1962a: 60; 1962b: 99). Furthermore SAUBERT (1957) has shown experimentally that this species is nitrogen heterotrophic, i. e. requires organic nitrogen compounds. It appears that the ecological conditions found in the Vaal Dam Catchment Area were unsuitable for the development of this species as it was seldom seen in the catchment area. It was recorded as single specimens from three samples collected from the Waterval River.
Samples — 338, 497, 498.

N. transvaalensis CHOLNOKY (1958b: 131, F. 139).
This very rare but easily distinguished species was present in two samples as isolated specimens. One example, 60 μ long, was slightly shorter than the dimension given in the description, and the original description should be amended with the addition of this information.
Samples — 340, 344.

N. tropica HUSTEDT (1949a: 147, T. 11, F. 34—48).
This species (Fig. 259) was rare in the catchment area, and was recorded in small numbers from seven localities in the Vaal and Waterval River Systems.
Figure 259.
Samples — 401, 410, 411, 412, 417, 418, 485.

N. tryblionella HANTZSCH (cf. HUSTEDT 1930: 399, F. 757).
Samples — 342, 344, 401, 402, 405, 415, 417, 489, 493.

N. umbilicata HUSTEDT (1949a: 129, T. 11, F. 65).
This species is very similar to *N. levidensis* GRUNOW, but differs from it in the shape of the valve and its much finer striation of the valve surface. In this survey some of the examples agreed fully with HUSTEDT's original description, while others differed in their dimensions, thus enlarging the range of variation of the species. Incorporating the Vaal observations the new range of variation is as follows: — length 27—40 μ, breadth 7—8 μ; carinal pores 8 in 10 μ; and transapical striae (Rippen) 18—22 in 10 μ. These examples constitute the first record of *N. umbilicata* for South Africa. Two examples have been illustrated, one showing a typical valve (Fig. 261) and the other (Fig. 260) showing one of the smaller examples with shorter protracted poles.
The species was mainly recorded from the Waterval River, but was never present in great numbers.
Figures 260, 261.
Samples — 340, 363, 378, 511, 513, 553, 554.

N. valdestriata ALEEM et HUSTEDT (1951: 19, F. 5).
This is a marine species and is out of place in the catchment area. CHOLNOKY (1959: 61; 1962a: 60) has recorded this species only from marine habitats from the Western Cape Province. The species was recorded in a sample from Station 5A and in a small tributary of the Vaal River in the same vicinity.
Samples — 404, 406.

N. Vandermerwei CHOLNOKY (1957c: 78, F. 113—115).
One very typical example of this species (Fig. 262) was observed in sample Vaal 442. This species is rare in South Africa.
Fig. 262.
Sample — 422.

N. vermicularis (KÜTZING) GRUNOW (cf. HUSTEDT 1930: 419, F. 811).
Sample — 323.

N. vitrea NORMAN var. *salinarum* GRUNOW (cf. HUSTEDT 1930: 411).
CHOLNOKY (1957a: 77) expressed some doubt whether this species is a marine or brackish water form. In the catchment area it was found in only two samples, where it did not appear to be autochthonous.
Figure 263.
Samples — 409, 478.

Pinnularia EHRENBERG 1840.

P. acoricola HUSTEDT (cf. HUSTEDT 1937—1939, Suppl. **15**: 293, T. 21, F. 11—16).
This species has been recorded from many acidic waters in South Africa (CHOLNOKY 1954b: 221; 1956: 85; 1960a: 106). In the catchment area the species was not particularly common, and was present in significant numbers in only three samples, two from the acid headwaters of the Vaal River (Vaal 301, 479) and the other from a headwater tributary of the Kleinvaal River.

P. acrosphaeria (BRÉBISSON) RABENHORST (cf. HUSTEDT 1930: 330; F. 610).
Samples — 307, 339.

P. brevicostata CLEVE var. *sumatrana* HUSTEDT (1937 bis 1939, Suppl. **15**: 398, T. 22, F. 4—6).
Only one specimen (Fig. 264) of this species was observed in this study. In South Africa the variety is rare and CHOLNOKY (1962b: 101; 1966a: 61) has recorded it twice from widely separated localities. In the catchment area the specimen was found in a sample collected from Lake Chrissie (Vaal 485).
Figure 264.
Sample — 485.

P. eburnea ZANON (under *P. dubitabilis* HUSTEDT 1949a: 105, T. 6, F. 11—13).
This is one of the more frequently occurring species of *Pinnularia* in South Africa, and CHOLNOKY (1962b: 101) regarded the species as acidophilic. On account of the generally alkaline conditions in the catchment area *P. eburnea* occurred in small numbers in a few samples.
Figure 265.

P. gibba EHRENBERG (cf. HUSTEDT 1930: 327, F. 600). It appears that a thorough revision of this species and its related varieties and forms is necessary. CHOLNOKY (1955c: 33; 1962a: 63; 1962b: 101; 1964: 78; 1966a: 62; 1966b: 210) claimed that intermediate stages between the typical forms, its varieties and forms were so numerous that it was impossible to distinguish between them. However, as so few specimens have been observed in the catchment area the different forms and varieties have been retained, since the presence of intermediates were not detected.
According to CHOLNOKY (1962b: 101) this species finds its optimum development at pH 6. Its slight occurrence in a few samples from the catchment is probably due to the unsuitable conditions found in the region.
Samples — 345, 347, 350, 353, 370, 479, 485.

P. gibba f. *subundulata* A. MAYER (cf. HUSTEDT 1930: 327, F. 601).
Samples — 370, 454, 456, 478.

P. gibba var. *linearis* HUSTEDT (1930: 327, F. 604).
Sample — 370.

P. gibba var. *parva* (EHRENBERG) GRUNOW (cf. HUSTEDT 1930: 327, F. 603).
Sample — 370.

P. gibba var. *sancta* HUSTEDT (1937—1939, Suppl. **15**: 395, T. 20, F. 35).
Samples — 353, 437, 485.

P. graciloides HUSTEDT (1937—1939, Suppl. **15**: 293, T. 22, F. 9, 10).
The distribution of the species appears to be linked with acid waters (CHOLNOKY 1960b: 263; 1962b: 102), and it was therefore not particularly common in the catchment area. It was recorded from two samples from the acid waters of Station 1 on the Vaal River, in two samples from Station 2A on the Vaal River, and in a sample from the Waterval River. The specimens found at Station 2a were probably washed downstream from Station 1, where the conditions were suitable for the growth of the species.
Samples — 301, 306, 307, 370, 554.

P. interrupta W. SMITH (cf. HUSTEDT 1930: 317, F. 573).
Samples — 301, 330, 449.

P. mesolepta (EHRENBERG) W. SMITH (cf. HUSTEDT 1930: 319, F. 575a).
P. mesolepta was found almost exclusively in the Vaal River, where it is probably not autochthonous except in the samples from the headwaters of the Vaal River (Vaal 301, 370, 479) where acid water was obtained. CHOLNOKY (1962b: 102) claimed that this species has a pH optimum of about pH 6.0, and therefore cannot be classed as „indifferent" (cf. HUSTEDT 1957: 307).
Samples — 301, 307, 345, 356, 370, 409, 464, 477, 479, 485.

P. microstauron (EHRENBERG) CLEVE (cf. HUSTEDT 1930: 320, F. 582).
As the pH optimum of this species lies around the neutral point the species occurred a little more frequently than other *Pinnularia* species, although it was less common than its variety, var. *Brebissonii* (KÜTZING) HUSTEDT.

P. microstauron f. *biundulata* O. MÜLLER (cf. HUSTEDT 1930: 320, F. 583).
This very rare form of the species has seldom been reported from South Africa. In the catchment area it was recorded from only two localities. i. e. the As River just below Bethlehem and from the Waterval River.
Samples — 239, 554.

P. microstauron var. *Brebissonii* (KÜTZING) HUSTEDT (1930: 321, F. 584).
This variety is relatively common in South Africa, and in the catchment area it was the most commonly occurring *Pinnularia* species. It was recorded from a relatively large number of localities, and was most abundant at Station 19 on the Kaffirspruit River.

P. minuta ZANON (1941: 51, T. 3, F. 23).
Samples — 233, 324.

P. stomatophora (GRUNOW) CLEVE (cf. HUSTEDT 1930: 327, F. 605).
The "strichartigen Zeichnungen" on either side of the central nodule used as a diagnostic feature in this species (HUSTEDT l. c.) has more recently been found to be unreliable as a diagnostic character (HUSTEDT 1937—1939, Suppl. **15**: 396), as occasionally it was found on one valve and not on the other of the same diatom cell. The example found in the Vaal Dam Catchment Area (Fig. 266) had the long and characteristic polar fissures but did not have the "strokelike marking" on either side of the central nodule. In dimensions it was similar to the smaller examples of this species found by CHOLNOKY (1966a: 65) from the Okawango material; it was 35 μ long and 5.5 μ broad.
This species was recorded from Lake Chirssie, which is fed by some acid water streams (CHOLNOKY 1965), and from the headwaters of the Russespruit Stream.
Figure 266.
Samples — 249, 485.

P. subdivergentissima CHOLNOKY (1958b: 136, F. 137).
A single specimen (Fig. 267) of the species was recorded from Station 24 on the Klip River near its headwaters.
Figure 267.
Sample — 437.

P. viridis (NITZSCH) EHRENBERG (cf. HUSTEDT 1930: 334, F. 617a).
CHOLNOKY (1960b: 265; 1962a: 65; 1962b: 103) has recorded this species many times from South Africa, and has found that its pH optimum lies between neutral point and pH 6.0, and that it prefers oligotrophic waters. As the rivers in the catchment area are generally alkaline in nature, this species occurred in small numbers in a few samples.

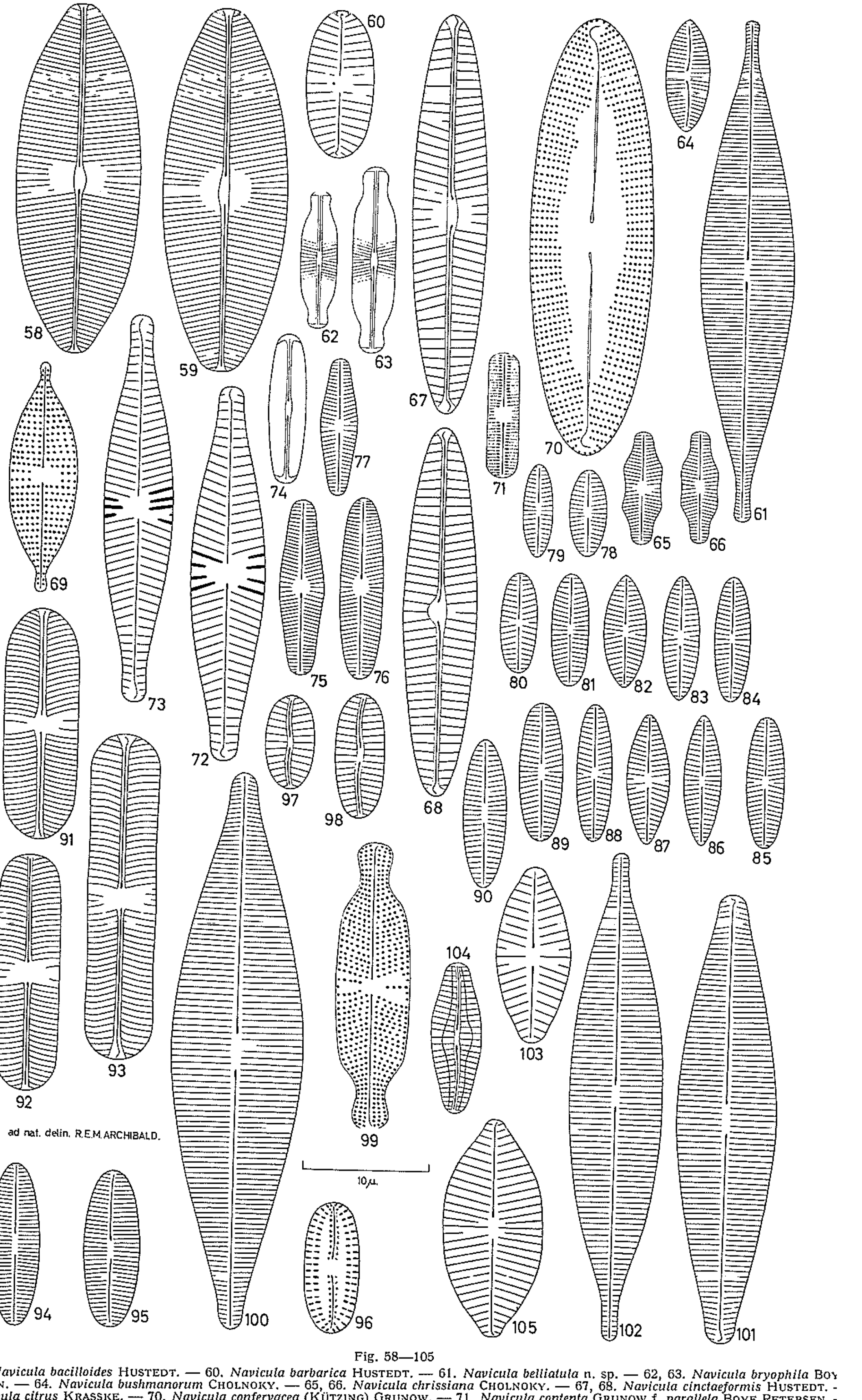


Fig. 58—105

58, 59. *Navicula bacilloides* HUSTEDT. — 60. *Navicula barbarica* HUSTEDT. — 61. *Navicula belliatula* n. sp. — 62, 63. *Navicula bryophila* BOY PETERSEN. — 64. *Navicula bushmanorum* CHOLNOKY. — 65, 66. *Navicula chrissiana* CHOLNOKY. — 67, 68. *Navicula cinctaeformis* HUSTEDT. - 69. *Navicula citrus* KRASSKE. — 70. *Navicula confervacea* (KÜTZING) GRUNOW. — 71. *Navicula contenta* GRUNOW f. *parallela* BOYE PETERSEN. - 72, 73. *Navicula cryptocephala* KÜTZING. — 74. *Navicula difficillima* HUSTEDT. — 75, 76. *Navicula digitulus* HUSTEDT. — 77. *Navicula diuturr* CHOLNOKY. — 78—90. *Navicula diuturnoides* ARCHIBALD. — 91—93. *Navicula esamangensis* FOGED. — 94, 95. *Navicula fluens* HUSTEDT. — 9 *Navicula Fritschii* LUND var. *dissipatoides* HUSTEDT. — 97, 98. *Navicula gilva* n. sp. — 99. *Navicula Grimmei* KRASSKE. — 100—102. *Navicu halophila* (GRUNOW) CLEVE. — 103. *Navicula Hambergii* HUSTEDT. — 104. *Navicula insociabilis* KRASSKE. — 105. *Navicula Geitleri* HUSTEI

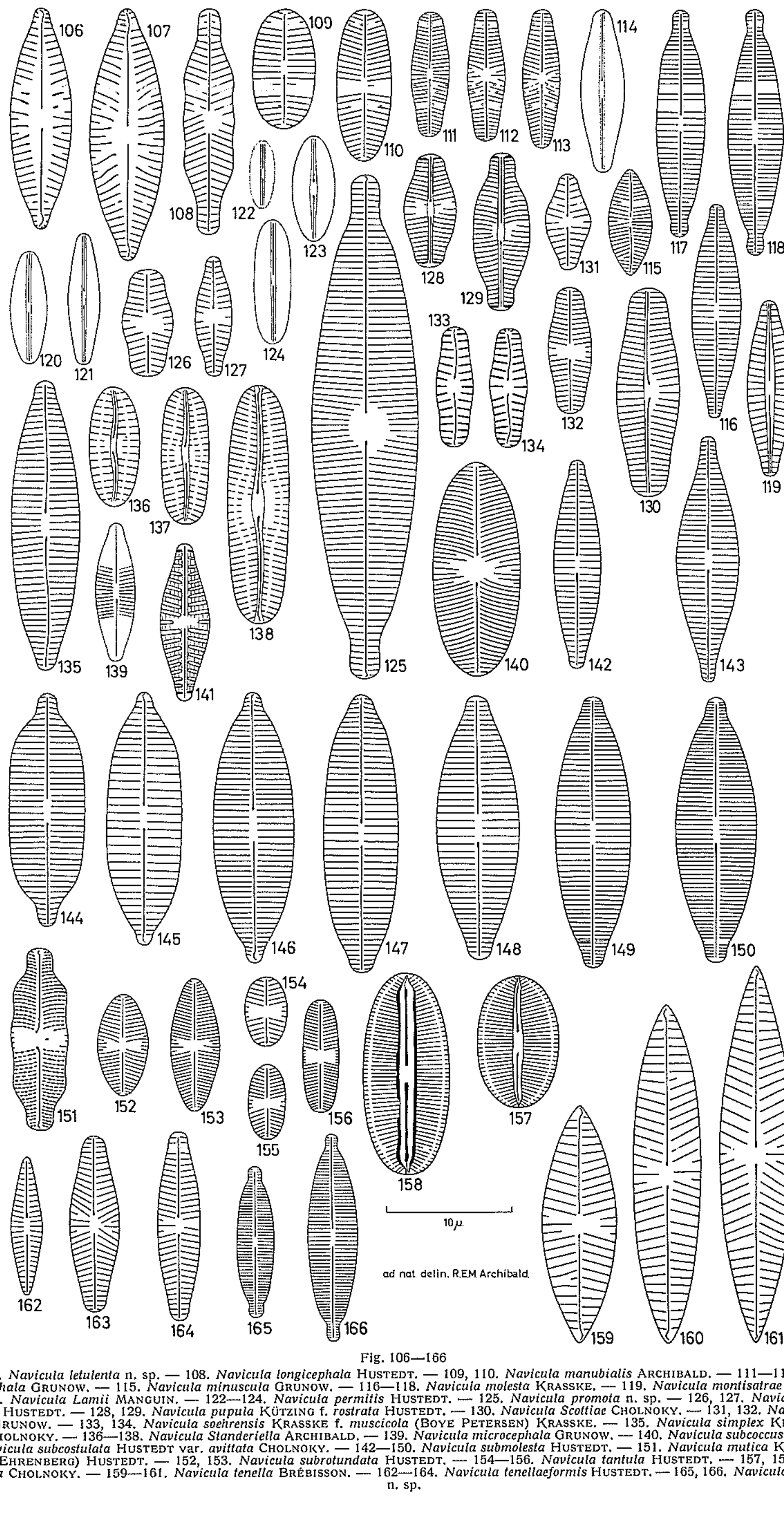


Fig. 106—166

106, 107. *Navicula letulenta* n. sp. — 108. *Navicula longicephala* HUSTEDT. — 109, 110. *Navicula manubialis* ARCHIBALD. — 111—114. *Navicula microcephala* GRUNOW. — 115. *Navicula minuscula* GRUNOW. — 116—118. *Navicula molesta* KRASSKE. — 119. *Navicula montisatrae* CHOLNOKY. 120, 121. *Navicula Lamii* MANGUIN. — 122—124. *Navicula permitis* HUSTEDT. — 125. *Navicula promota* n. sp. — 126, 127. *Navicula pseudoventralis* HUSTEDT. — 128, 129. *Navicula pupula* KÜTZING f. *rostrata* HUSTEDT. — 130. *Navicula Scottiae* CHOLNOKY. — 131, 132. *Navicula seminulum* GRUNOW. — 133, 134. *Navicula soehrensis* KRASSKE f. *muscicola* (BOYE PETERSEN) KRASSKE. — 135. *Navicula simplex* KRASSKE var. *minor* CHOLNOKY. — 136—138. *Navicula Standeriella* ARCHIBALD. — 139. *Navicula microcephala* GRUNOW. — 140. *Navicula subcoccus* CHOLNOKY. 141. *Navicula subcostulata* HUSTEDT var. *avittata* CHOLNOKY. — 142—150. *Navicula submolesta* HUSTEDT. — 151. *Navicula mutica* KÜTZING var. *nivalis* (EHRENBERG) HUSTEDT. — 152, 153. *Navicula subrotundata* HUSTEDT. — 154—156. *Navicula tantula* HUSTEDT. — 157, 158. *Navicula temeraria* CHOLNOKY. — 159—161. *Navicula tenella* BRÉBISSON. — 162—164. *Navicula tenellaeformis* HUSTEDT. — 165, 166. *Navicula tennissima* n. sp.

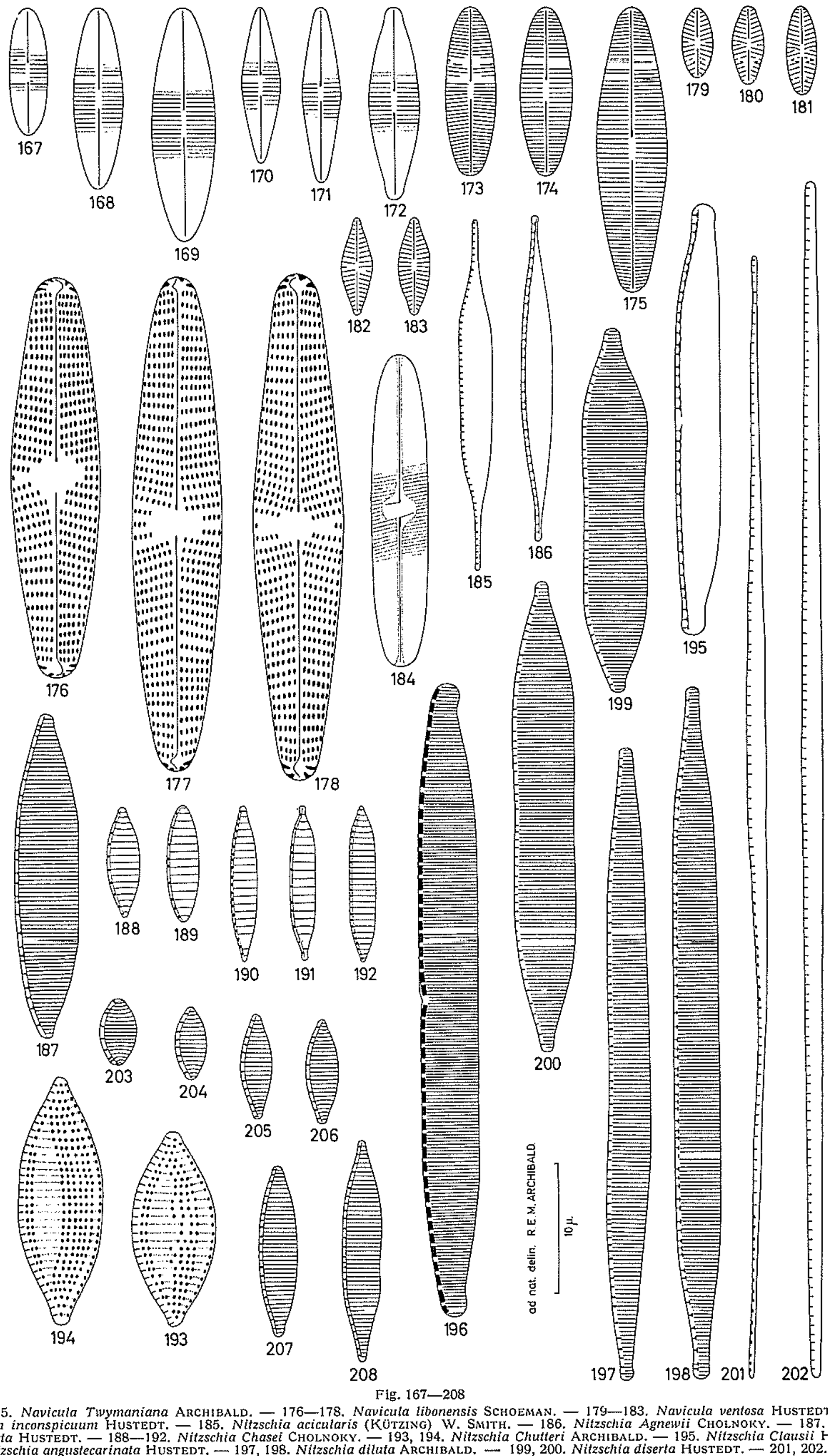


Fig. 167—208

167—175. *Navicula Twymaniana* ARCHIBALD. — 176—178. *Navicula libonensis* SCHOEMAN. — 179—183. *Navicula ventosa* HUSTEDT. — 184
Neidium inconspicuum HUSTEDT. — 185. *Nitzschia acicularis* (KÜTZING) W. SMITH. — 186. *Nitzschia Agnewii* CHOLNOKY. — 187. *Nitzschi*
capitellata HUSTEDT. — 188—192. *Nitzschia Chasei* CHOLNOKY. — 193, 194. *Nitzschia Chutteri* ARCHIBALD. — 195. *Nitzschia Clausii* HANTZSCH
196. *Nitzschia angustecarinata* HUSTEDT. — 197, 198. *Nitzschia diluta* ARCHIBALD. — 199, 200. *Nitzschia diserta* HUSTEDT. — 201, 202. *Nitzschi*
demota nov. nom. — 203—208. *Nitzschia fonticola* GRUNOW

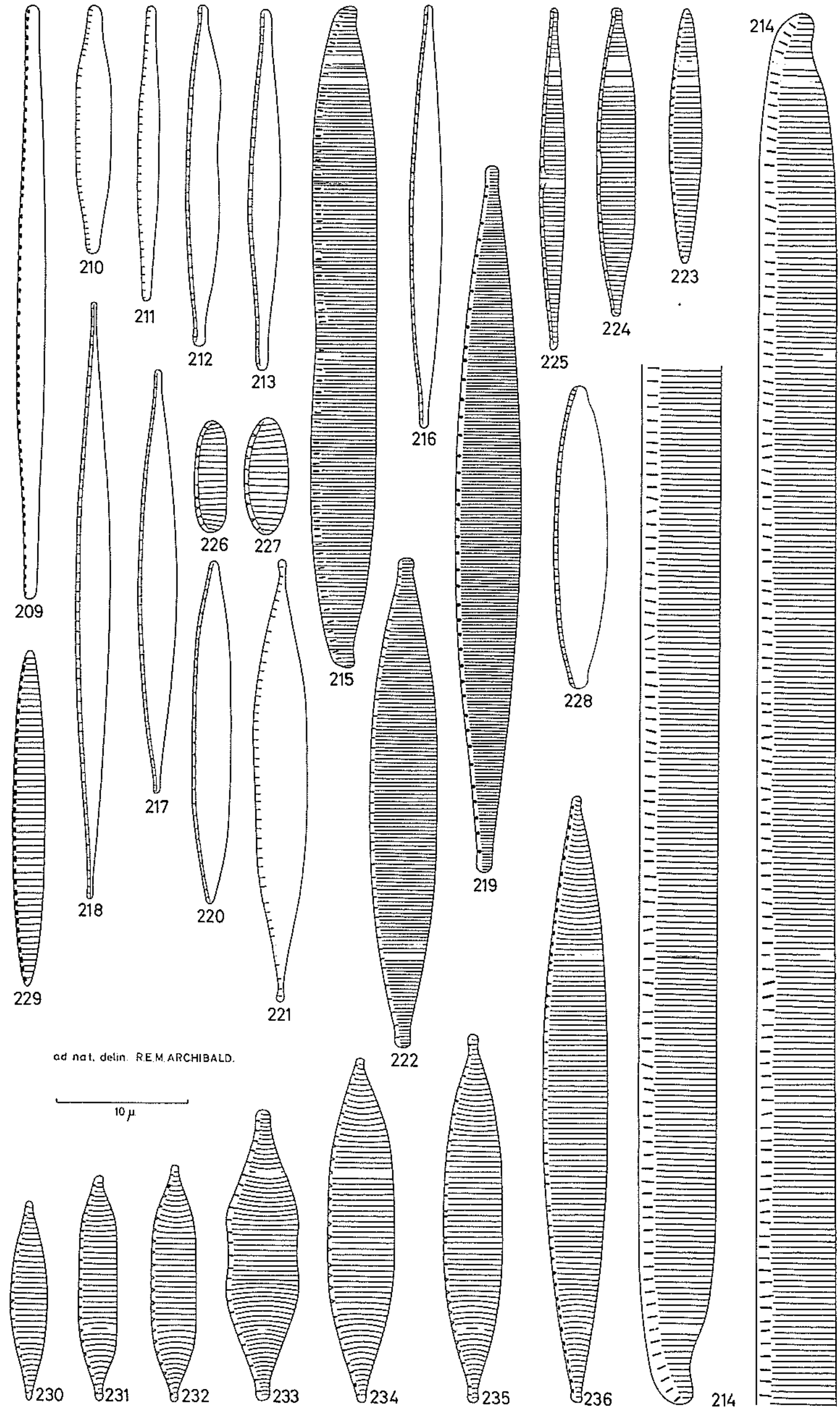


Fig. 209—236

209. *Nitzschia gracilis* Hantzsch. — 210—213. *Nitzschia Kuetzingiana* Hilse. — 214. *Nitzschia lauenburgiana* Hustedt. — 215. *Nitzschia linearis* (Agardh) W. Smith. — 216. *Nitzschia mediocris* Hustedt. — 217, 218. *Nitzschia obligata* Archibald. — 219. *Nitzschia obsidialis* Hustedt. — 220—222. *Nitzschia palea* (Kützing) W. Smith. — 223—225. *Nitzschia perminuta* Grunow. — 226, 227. *Nitzschia perpusilla* Rabenhorst. 228. *Nitzschia perspicua* Cholnoky. — 229. *Nitzschia procima* Hustedt. — 230—236. *Nitzschia romana* Grunow

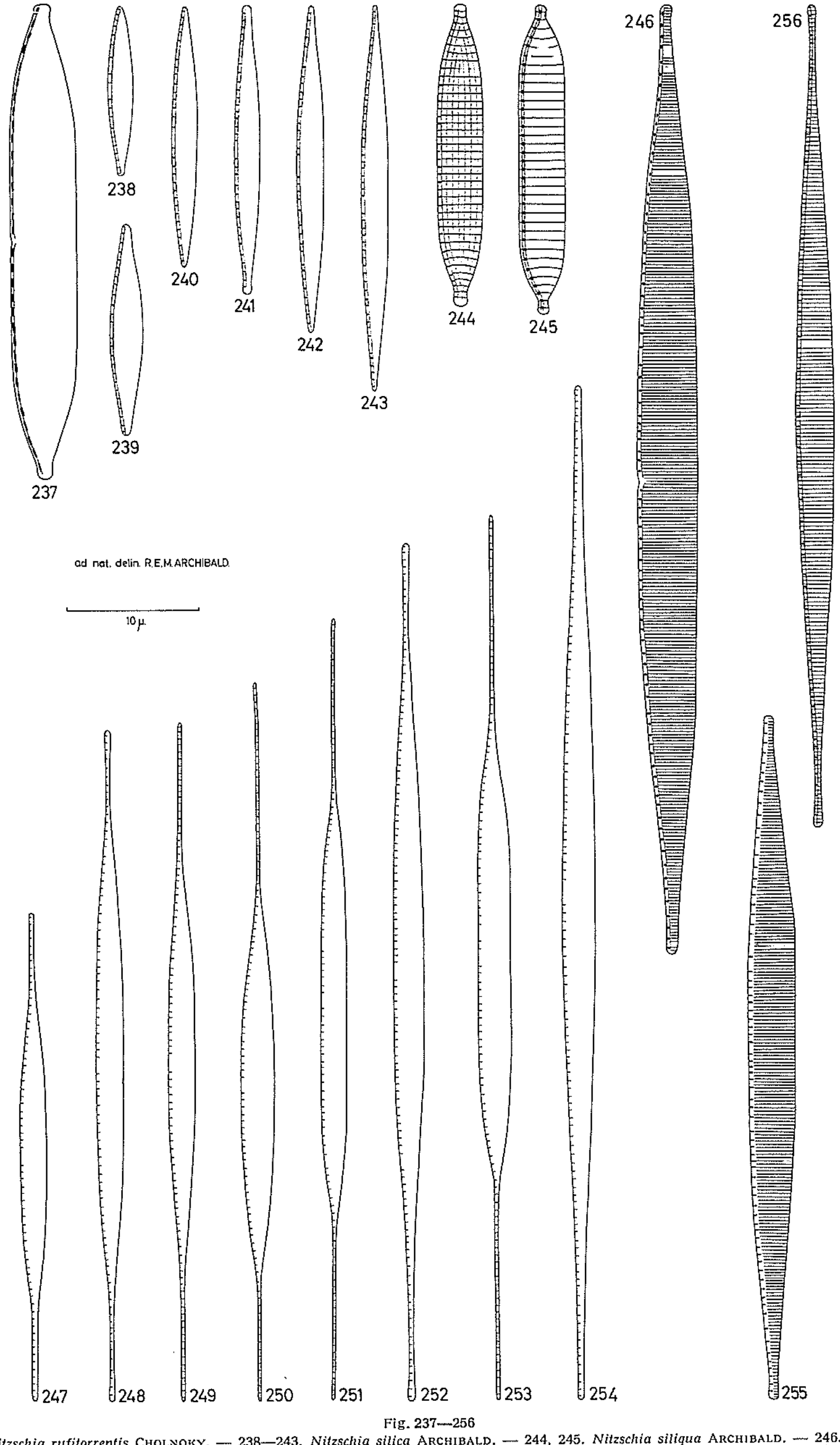


Fig. 237—256

237. *Nitzschia rufitorrentis* CHOLNOKY. — 238—243. *Nitzschia silica* ARCHIBALD. — 244, 245. *Nitzschia siliqua* ARCHIBALD. — 246. *Nitzschia spiculoides* HUSTEDT. — 274—254. *Nitzschia spiculum* HUSTEDT. — 255. *Nitzschia strica* HUSTEDT. — 256. *Nitzschia subacicularis* HUSTEDT

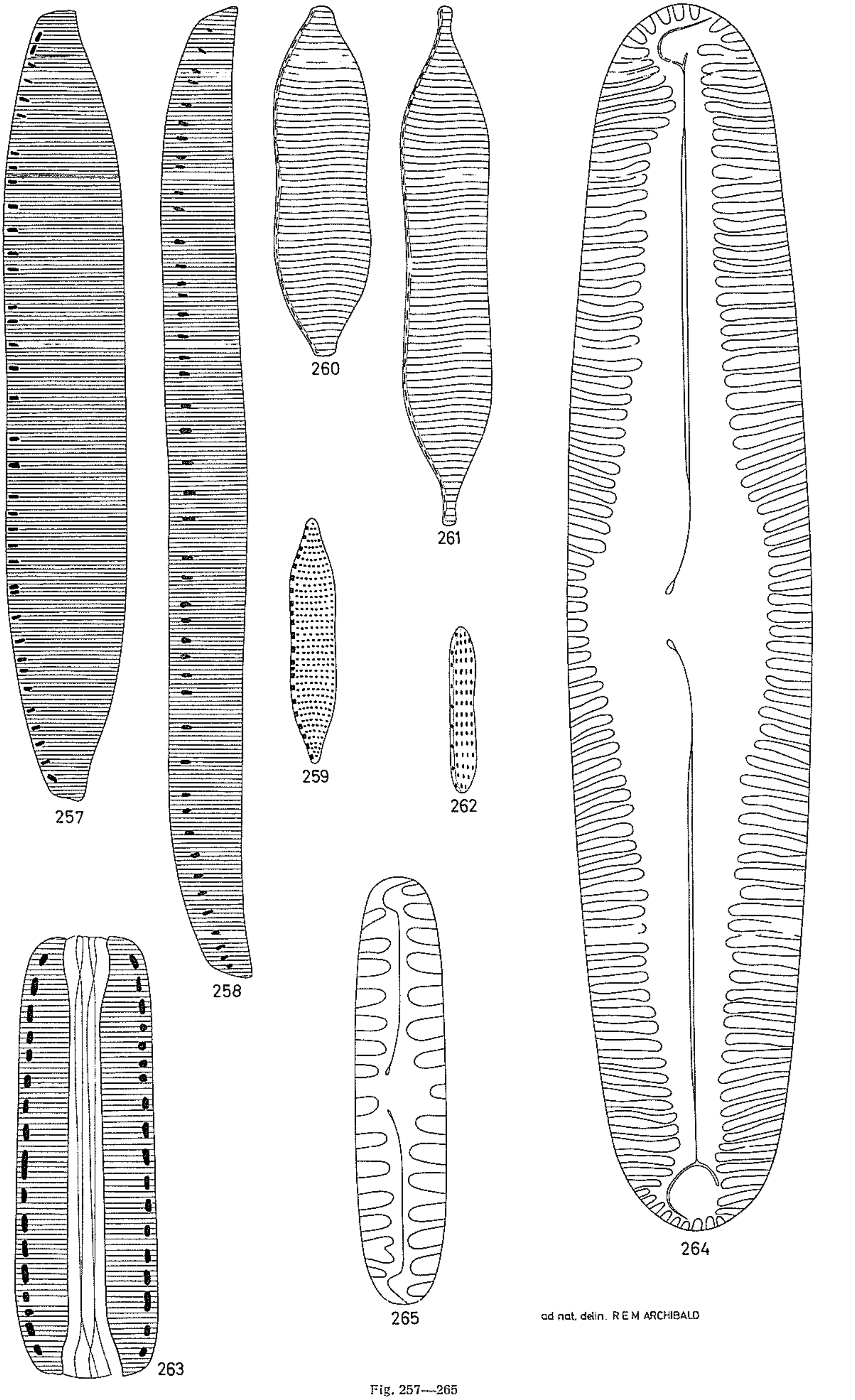


Fig. 257—265

257—258. *Nitzschia subvitrea* HUSTEDT. — 259. *Nitzschia tropica* HUSTEDT. — 260, 261. *Nitzschia umbilicata* HUSTEDT. — 262. *Nitzschia Vandermerwei* CHOLNOKY. — 263. *Nitzschia vitrea* NORMAN var. *salinarum* GRUNOW. — 264. *Pinnularia brevicostata* CLEVE var. *sumatrana* HUSTEDT. 265. *Pinnularia eburnea* ZANON

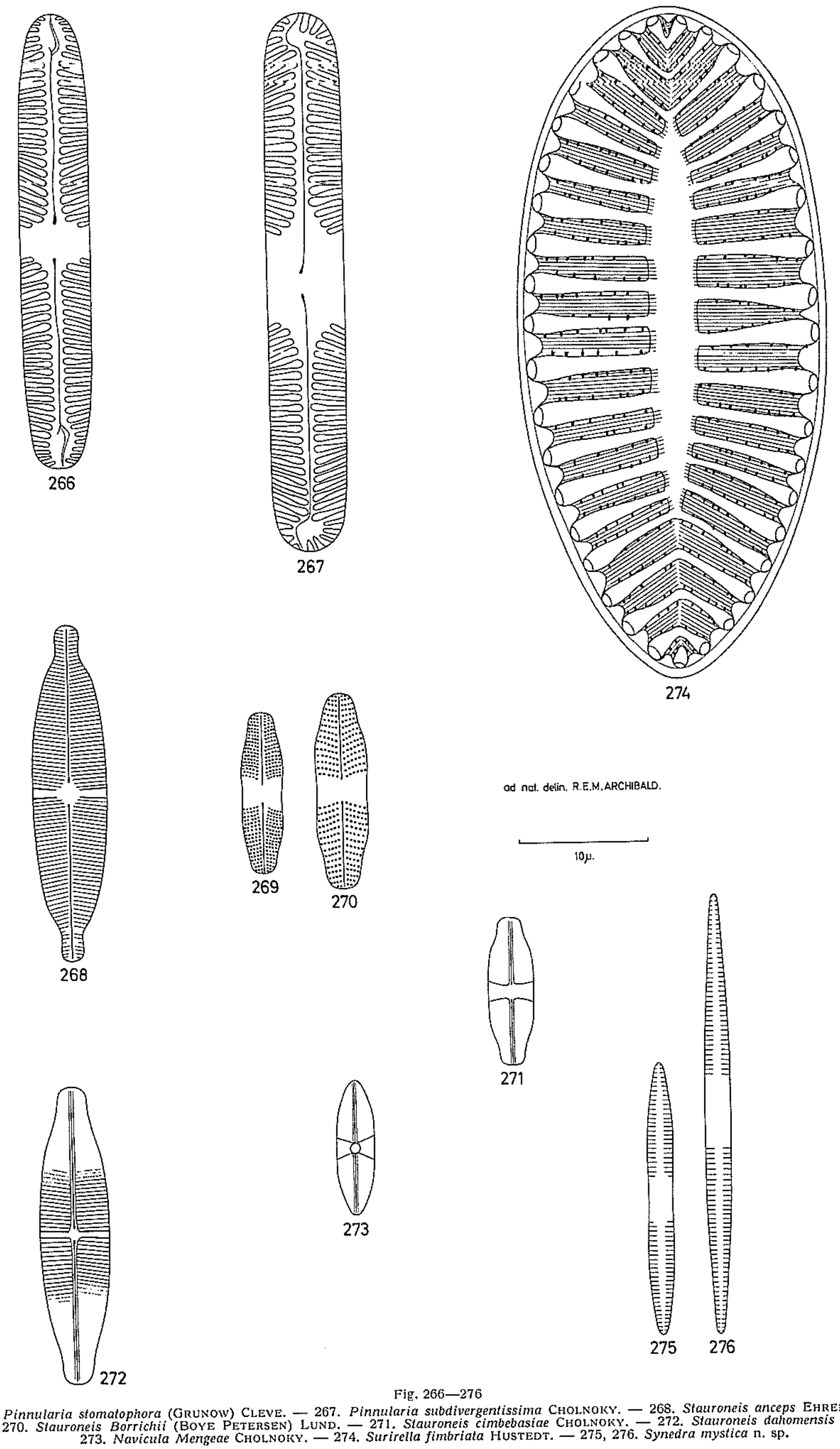


Fig. 266—276

266. *Pinnularia stomatophora* (GRUNOW) CLEVE. — 267. *Pinnularia subdivergentissima* CHOLNOKY. — 268. *Stauroneis anceps* EHRENBERG. — 269, 270. *Stauroneis Borrichii* (BOYE PETERSEN) LUND. — 271. *Stauroneis cimbebasiae* CHOLNOKY. — 272. *Stauroneis dahomensis* HUSTEDT. 273. *Navicula Mengeae* CHOLNOKY. — 274. *Surirella fimbriata* HUSTEDT. — 275, 276. *Synedra mystica* n. sp.

Tabellaria EHRENBERG 1839.

T. flocculosa (ROTH) KÜTZING (cf. HUSTEDT 1927—1964, Teil 2: 29, F. 558).
Samples — 353, 485.

Thalassiosira CLEVE 1873.

T. decipiens (GRUNOW) JOERGENSEN (cf. HUSTEDT 1927 bis 1964, Teil 1: 322, F. 158).
Sample — 344.

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