ON THE CONTINENTAL COPEPOD FAUNA OF MOROCCO[1]

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Abstract

A series of samples, collected in different parts of Morocco, contained 26 species and one subspecies of Copepoda. Ten among these are new to the fauna of Morocco and one is new to Science. Two species *(Eucyclops hadjebensis* Kiefer and *Mixodiaptomus laciniatus atlantis* Kiefer) are endemic to Morocco; *Afrocyclops gibsoni* Brady and *Thermocyclops schuurmanae* Kiefer are Ethiopan species. The former reaches its limit of Northern extent East of the Atlas mountains; the latter is a pluvial relict. The remaining species have either a cosmopolitan, circummediterranean or North-African distribution, with the exception of *Cyclops abyssorum mauretaniae* which is a southern element of the Eurasiatic genus Cyclops. Its taxonomical status is reviewed in some detail. *Thermocyclops infrequens* Kiefer is synonymized with *T. schuurmanae* Kiefer. It is concluded that the largest gaps in our knowledge of the Copepoda of Morocco are now in the group of the Harpacticoida.

Sommaire

Dans les échantillons étudiés, 26 espèces et une sous-espèce de Copépodes ont été trouvés. Dix sont nouvelles pour le Maroc et une nouvelle pour la science. Parmi les espèces réputées endémiques du Maroc, *Mixodiaptomus laciniatus atlantis* Kiefer et *Eucyclops hadjebensis* ont été retrouvés. La dernière espèce n'avait plus été retrouvée avec certitude depuis sa découverte en 1926. Trois stations à l'est de l'Atlas ont données pour *Afrocyclops gibsoni* Brady, espèce réputée éthiopienne. Le représentant Maroccain du groupe Cyclops s.str. est étudié en détail. Des remarques générales sur l'état actuel de la systématique du genre sont formulées. Les populations maroccaines sont sujettes à de fortes variations locales et il est conclu que l'état actuel de nos connaissances ne permet pas de les séparer en taxa distincts. Quant au genre *Thermocyclops:* il s'agit d'un groupe

thermophile comptant beaucoup d'espèces en Afrique tropicale, mais dont des reliques des ages pluviaux ont subsisté au Maroc. L'un parmi eux, le *Thermocyclops schuurmannae* Kiefer, 1928, déjà trouvé au Maroc par Lindberg (1950), est analysé par morphométrie et comparé à une espèce Africaine proche, le *Thermocyclops infrequens* Kiefer, 1929. La conclusion est qu'une séparation spécifique des deux entités n'est pas justifiée. Une deuxième espèce du même genre, le *Thermocyclops dybowskii* (Lande), vit dans les lacs de l'Atlas. C'est une espèce largement répandue en Europe et en Asie, mais qui est très étroitement liée à l'espèce Africaine, *Thermocyclops* schmeili (Poppe & Mrazek). Parmi les Harpacticides, plusieures additions à la faune du Maroc sont à retenir. Le caractère composé de la faune maroccaine est mis en évidence. Quelques lacunes faunistiques restant à combler sont brièvement indiquées.

Introduction

Our present knowledge of the Copepod fauna of Morocco is due to Kiefer (1928, 1938, 1954), Lindberg (1950, 1951), Vivier (1948, 1949), François (1949), Gayral & Panouse (1954), Brehm (1954), De Lépiney (1959, 1961), Panouse (1963) and Dumont et al. (1973). The picture obtained is an intriguing one, in which one meets elements of very different origin and nature, but which tell us a great deal about the immediate geological past of North Africa. In this perspective, the further study of the Copepoda of Morocco is a challenge and a joy to the mind. It takes us back to the times when the glaciers on the Atlas mountains took great extension and *Cyclops abyssorum* could probably first settle here. It also takes us back to times when rainfall on the Sahara was much more abundant than today, with the Savannah approaching the mediterranean and many tropical Cyclopids advancing north. Anything that we might be able to

learn about these phenomena, be it in the tiny animals that were left behind, is of some significance if seen in the light of what mankind is planning to do in order to remodel these territories and make them more fit for living.

Material

All the animals discussed here were collected by the authors at the occasion of the Gent University expedition to Morocco in the summer of 1971. Some additional samples had been collected earlier by the senior author, during a reconnaissance tour to Morocco in April 1971.

List of Localities

I. Spring 1971.
Loc. 1. Pond at Rommani, 26.IV.1971.
Loc. 2. Pool in the bed of Asif Imini, on road of Tiz-n-Tichka (ca. 1500 m), 27.IV.1971
Loc. 3. Pond near Atlantic Ocean, between Oualidia and El Jadida, presumably brackish, 29.IV.1971.
Loc. 4. Dayat near Casablanca. 22.IV.1971.

II. Summer 1971.
Loc. 5. Dayat Drouka (Ifrane), 22.VII.1971.
Loc. 6. Dayat Ifrah (Ifrane), 21.VII. and 23.VII.1971.
Loc. 7. Source Vittel (Ifrane), 22.VII.1971.
Loc. 8. Dayat Iffer, 22.VII. and 23.VII.1971.
Loc. 9. Dayat Aaoua, 22.VII.1971.
Loc. 10. Small Dayat near Timahdite, 24.VII.1971.
Loc. 11. Aguelmane de Sidi Ali(Col de Zad), 24.VII.1971.
Loc. 12. Small pool near Aguelmane de Sidi Ali, 24.VII.1971.
Loc. 13. Dam near Ksar-es Souk, 28.VII.1971.
Loc. 14. Swamps in bed of River ZIZ at Meski, 28.VII.1971.
Loc. 15. Source bleue at Meski, 26.VII.1971.
Loc. 16. Cemented saline source in presahara near Merzouga, 27.VII.1971.
Loc. 17. Dayat Srij (Merzouga), 27.VII.1971.
Loc. 18. Pool at Rissani, 27.VII.1971.
Loc. 19. Source des poissons sacrés (Tinerhir), 29.VII.1971.
Loc. 20. Lake Ifni, Toubkal Massif, 2.VIII.1971.
Loc. 21. Source on flancs of Jbel Toubkal (at 3200 m), 3.VII.1971.

Loc. 22. Barrage Cavagnac, 4.VIII.1971.
Loc. 23. Pool near Ksar-el-kebir (Rharb), 5.VIII.1971.

List of species recorded

The species marked with an asterisk are either new to Morocco or new to science. Number(s) behind each species refer to the localities given above.

a. Calanoida
1. *Lovenula (Neolovenula) alluaudi* (Guerne & Richard, 1894): 4.
2. *Mixodiaptomus laciniatus atlantis* (Kiefer, 1954): 6, 10, 11.
3. *Mixodiaptomus incrassatus* (Sars, 1903): 4.
4. *Arctodiaptomus wierzejskii* (Richard, 1888): 4.

b. Cyclopoida
5. *Macrocylops albidus* (Jurine, 1820): 6, 8, 9.
6. *Eucyclops hadjebensis* (Kiefer, 1926): 7.
7. *Eucyclops serrulatus* (Fischer, 1851): 1, 2, 3, 5, 6, 8, 9, 10, 14, 15, 22, 23.
* 8. *Eucyclops speratus speratus* (Lilljeborg, 1901): 6, 21.
* 8a. *Eucyclops speratus ifniensis* subspec.n.: 20.
* 9. *Afrocyclops gibsoni* (Brady, 1904): 15, 17, 19.
10. *Tropocyclops p. prasinus* (Fischer, 1760): 5, 8, 9, 13, 14, 15, 18, 19, 22, 23.
11. *Paracyclops fimbriatus* (Fischer, 1853): 11, 17.
*12. *Paracyclops affinis* (Sars, 1863): 8.
13. *Cyclops abyssorum mauritaniae* (Lindberg, 1950): 6, 11, 20.
14. *Megacyclops viridis* (Jurine, 1820): 11, 12, 13, 17.
15. *Diacyclops biceuspidatus odessanus* (Schmankevitch, 1875): 1, 4, 10.
16. *Thermocyclops schuurmannae* Kiefer, 1928: 22.
*17. *Thermocyclops dybowskii* (Landé, 1890): 6, 11.
*18. *Acanthocyclops vernalis* (Fischer, 1853): 11.
19. *Metacyclops minutus* (Claus, 1863): 4.

c. Harpacticoida
20. *Canthocamptus staphylinus* (Jurine, 1820): 1, 4.
*21. *Bryocamptus zschokkei* (Schmeil, 1893): 21.
22. *Attheyella crassa* (Sars, 1862): 11, 21.
23. *Attheyella trispinosa* (Brady, 1880): 23.
*24. *Onychocamptus mohammed* (Blanchard & Richard, 1891): 14.

*25. *Cletocamptus retrogressus* (Schmankevitch 1875): 3.

*26. *Nitrocrella ioneli* Dumont & Decraemer, 1975: 16.

With regard to previous work, our collection is poor in Calanoids, which appear to be largely restricted to the Atlantic coastal plain, but relatively rich in Cyclopoida and Harpacticoida. The last result is particularly encouraging, as the true benthos samples collected by the expedition have to date remained unstudied. They are prone to yield some more species. On the whole, ten species and subspecies new to Morocco fall to be recorded, one among which is new to science.

Comments on selected species

1. *Mixodiaptomus laciniatus atlantis* Kiefer, 1954.

Kiefer's (1954) subspecies had first been reported and figured by François (1949). We here represent the P_5 of a male specimen from Dayat Ifrah (Fig. 1.), quite identical to Kiefer (1954): 330 and François (1949): 194. It is widespread in the Dayats of the Middle Atlas. According to Dussart (1965), it might extend to Spain and perhaps reach the French Pyrénées.

2. *Eucyclops hadjebensis* Kiefer, 1926: Fig. 2.

An easily recognizable Eucyclops, first collected by Jeannnel in 1924 and described by Kiefer in 1926. No precise data on the conditions of the type locality are known. A plankton sample taken near the outlet of Source Vittel, between El Hajeb and Ifrane, has now yielded a long series of specimens, in both sexes. The sampling spot was, in fact, a standing water branch at the outlet of the source, in which a thick, rusty sediment accumulates. *Eucyclops hadjebensis* here leads a semibenthonic life. It might in fact be a troglobiont that is locally carried to the surface by accident.

Our material corresponds well with Kiefer's original description, and the female is figured here in extense (Fig. 2). The structure of P_5 and of the receptaculum seminis are as in *Eucyclops serrulatus*. The serra on the external margin of the furca is reduced, but more variable than hitherto known. Fig. 2, D and 2, E, show two extreme types. The spine formula is as in *E. serrulatus* and so is the structure of Endopodite 3 of P_4. Very distinctive is the structure of the setae on the exopodites 3 of the thoracopods. They were described by Kiefer, for Exopodite 3 of P_4, as spine-shaped. A re-examination on a rich material

shows that these setae are, in fact, swollen in their proximal half, then abruptly narrowing to appear somewhat knife-shaped. Their inner surface is set with the usual long hairs; their outer surface bears short, spine-like hairs. This character is still seen on P_3 and P_2, but in P_2 only the three distal setae are modified and to a lesser degree than on the preceding thoracic limbs. In P_1, the modification of the setae appears insignificant. Also distinctive is the structure of the terminal setae on the furca: the inner one is relatively short and the two medial ones are set with numerous short spines, quite different from what is seen in *E. serrulatus* and *E. speratus* (cfr. Fig. 4).

Eucyclops hadjebensis not only appears as an endemic species of the Middle Atlas, but as an endemic of the valley of Source Vittel. A single egg-bearing female, found in the roman artesian pond of Héliopolis near Guelma (Algeria) has been assigned to this species by Roy & Gauthier (1927). Until confirmation, this record should, however, be considered doubtfull.

3. *Eucyclops serrulatus* (Fischer, 1851).

It is generally felt that under the name *serrulatus* is grouped a set of taxonomic entities, but all efforts to unravel the complex have so far remained unsuccessfull or have complicated the problem even more. *Eucyclops serrulatus* is cosmopolitan and ubiquitous to an almost incredible degree. It occurs in pools, ponds, small eutrophic and large oligotrophic lakes; it is found in caves and other subterranean habitats; it lives in fresh and brackish, standing and running water. Above all, it varies tremendously in shape, colour and the relative proportions of parts of its body. Moroccon populations are by no means an exception to this rule, showing extreme plasticity, before all in the structure of the furca. Kiefer (1954: 332) made a plea for a renewed study of this group, being struck by the astonishing variability of the moroccon material before him ('*Eucyclops* cfr. *serrulatus*'). Having examined long series of animals from many places in Morocco, there is little we can add to Kiefer's statement, except for maintaining a specific distinction between *E. serrulatus* and the species to be treated next, *E. speratus*. A new entry to the list of variable characters must also be made: in Moroccon populations we have met two types of serrae on the furca (Fig. 3). The first is the common type (Fig. 3, A: Dayat Iffer and most other localities); the second has the spines on the margin of the furca deviating towards the base of the lateral seta (Fig. 3, B: Meski). The latter type of furca also occurs in *E. speratus* (Fig. 3, C; 4, A). It does not seem to have taxonomic meaning.
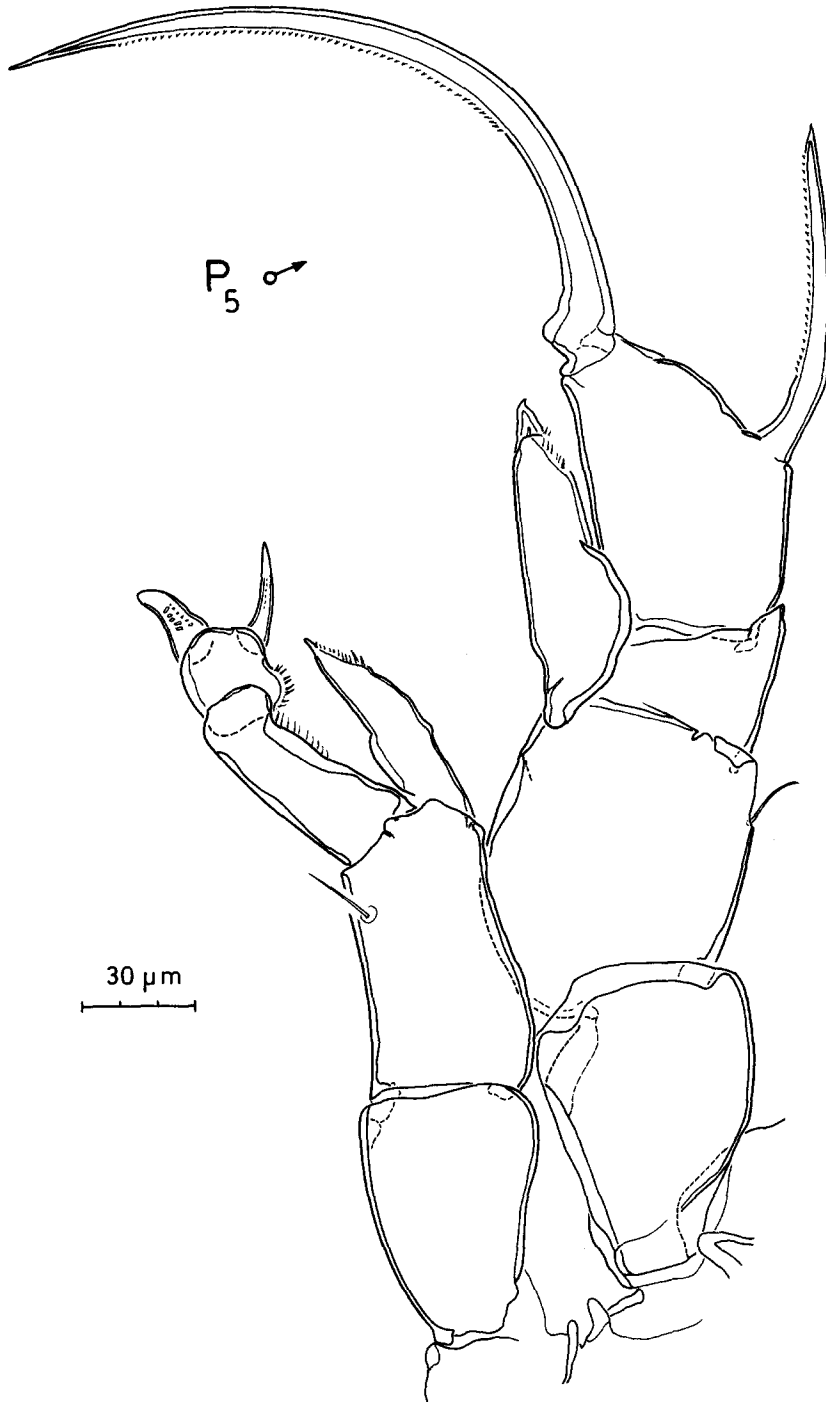
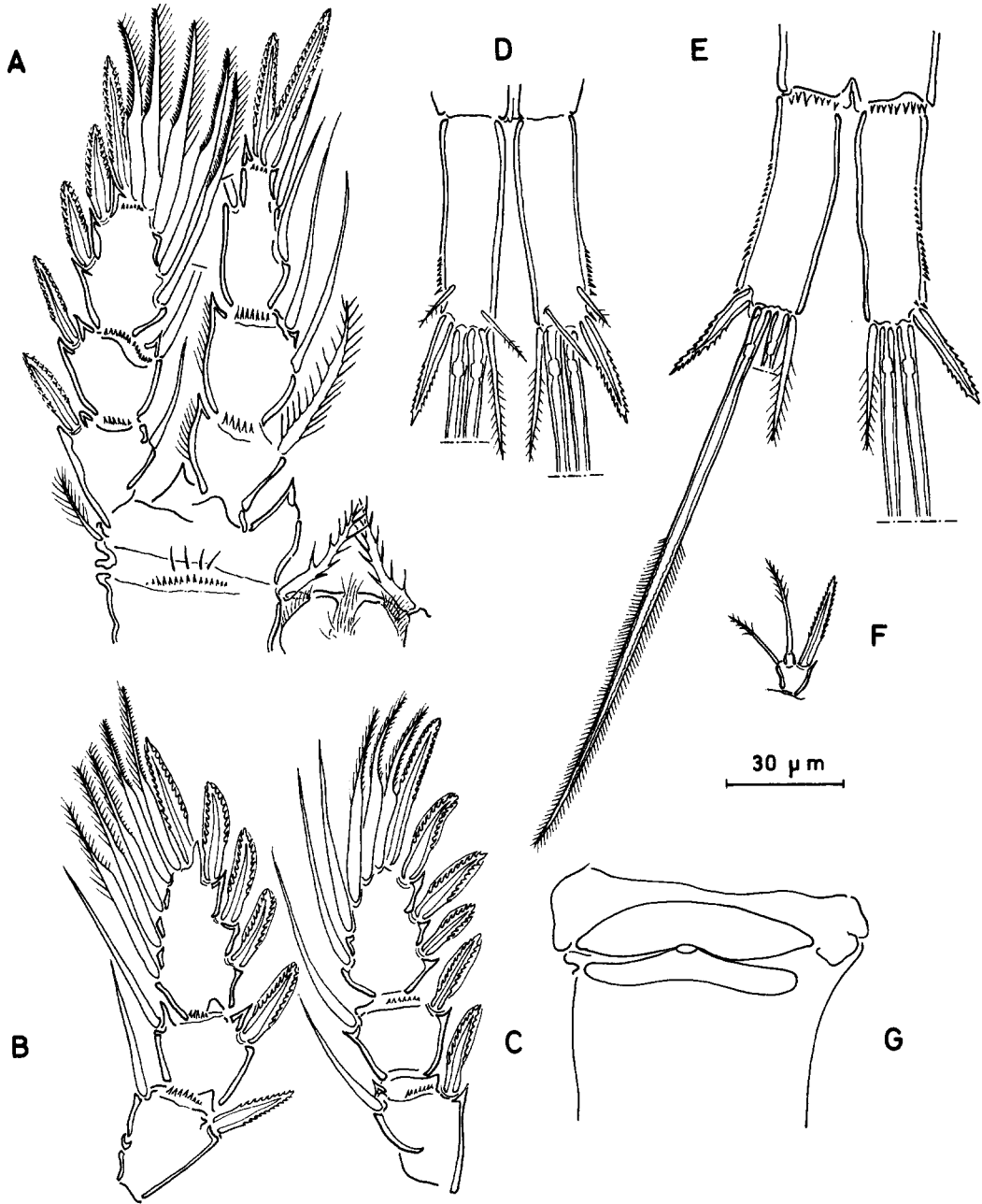Fig. 1. *Mixodiaptomus laciniatus atlantis* Kiefer, 1954, P₅ ♂.

Fig. 2. *Eucyclops hadjebensis* Kiefer, 1926. A. P₄; B. P₃, exopodite; C. P₂, exopodite; D, E: Furca; F. P₅; G. receptaculum seminis.

4. *Eucyclops speratus* (Lilljeborg, 1901).
This species has, since its description, been subject to in-numerable status changes. It has alternatively been considered as a full species, a subspecies or a statusless ecotype. Even in the work of one and the same author, one may see these transfers occur again and again, a matter for confusion and regret. In more recent fauna's some stability has been reached (e.g. Kiefer, 1960; Dussart, 1969) and *Eucyclops speratus* is referred to as a species. We ally ourselves to this point of view, for several reasons. First, both species differ by their furcal structure (Fig. 4, 5) and by their size, *E. speratus* being a larger animal. Second, both species may, at times, co-occur. Third, there is a difference in habitat selection, *E. speratus* being much more selective than *E. serrulatus*. It is generally, though not exclusively, found in the smallest bodies of water (Dussart, 1969).

In Morocco, we found a fairly typical population in the litoral of lake Ifrah (Fig. 4, F) where it lived together with *E. serrulatus*; on the flancs of Jbel Toubkal, in a small source at an altitude of 3200 m, a rich population was found that had a serra-structure as the *E. serrulatus* from Meski (Fig. 4, A).

Animals from the litoral of lake Ifni are so different, that it seems best to describe them as a new subspecies.

4.a. *Eucyclops speratus ifniensis* subspec. nov.: Fig. 5.
Material: two adult females. Holotype and Paratype in the senior author's collection at the Zoological Institute, the state University of Gent.
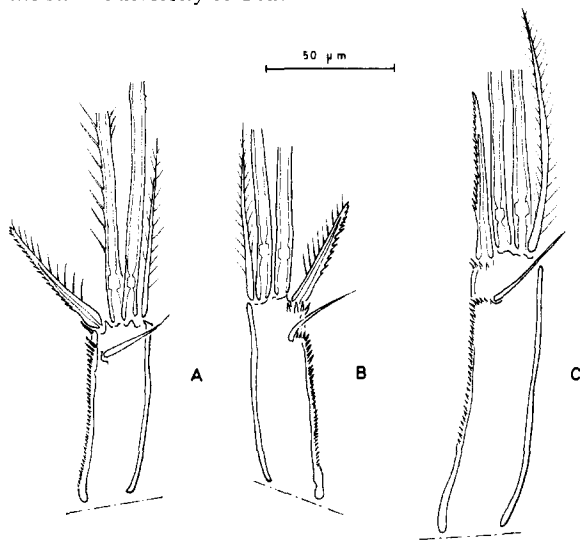

Fig. 3. Furca of *Eucyclops serrulatus* (A, B) and *Eucyclops speratus* (C).

Type locality: litoral of Lake Ifni, Toubkal Massif (High-Atlas) 2.VIII.1971.

Description: Habitus normal (measurements impossible: both specimens dissected). The hyaline membrane on the terminal segments of the first antenna as in typical *serrulatus* and *speratus*. Furca: branches long, divergent at tips, with fairly long external serra and a second, dorso-lateral partial serra. At the level of the implant of the lateral seta, semi-circular groups of spines. A transverse short row of spines on the basal fourth of the furca (the latter character also present in the Jbel Toubkal animals). Receptaculum seminis and P_5 typical; genital segment (and the following segments likewise) set with rows of numerous small spinules.

Endopodite 3 of P_4: the external seta distinctly shorter than normal, not reaching halfway the outer apical spine (Fig. 5, B; compare with Fig. 4, D, E). The inner setae also somewhat shortened. The proposed new subspecies lives along the rocky shores of isolated Lake Ifni, at an altitude of ca. 2400 m.

5. *Afrocyclops gibsoni* (Brady, 1904).
The discovery of this species in Morocco has been announced earlier (Dumont, 1971). It has some bio-geographical impact. *Afrocyclops gibsoni* is indeed widely distributed and common in Ethiopian Africa, where it occurs in a wide variety of biotopes, ranging from ponds and pools to large lakes. Although there is a single citation by Roy (1929) from Tamanrasset (Hoggar mountains), the species was believed not to extend beyond the limits of the Sahara. We have now found *Afrocyclops gibsoni*, in some abundance, in three different stations East of the Atlas mountains and in a subdesertic environment. During the Quarternary pluvials, *A. gibsoni* certainly extended up to the mediterranean. Our populations are to be considered as colonies that remained established in perennial waters, following the drying-up of the Sahara. It may be predicted to occur in all permanent water-bodies of not too high salinity within the boundaries of the desert.

Kiefer (1952), studying populations from Central Africa, created three subspecies. These were recently (Einsle, 1970) reduced to two. Our own material (Table 1) is scarcely distinguishable from typical *Afrocyclops gibsoni gibsoni*. It is to be noted that the males are slightly smaller than the females (0.90 mm and 0.94 mm), and that the mean furcal index in the females (9.4) is distinctly higher than in the males (7.5).
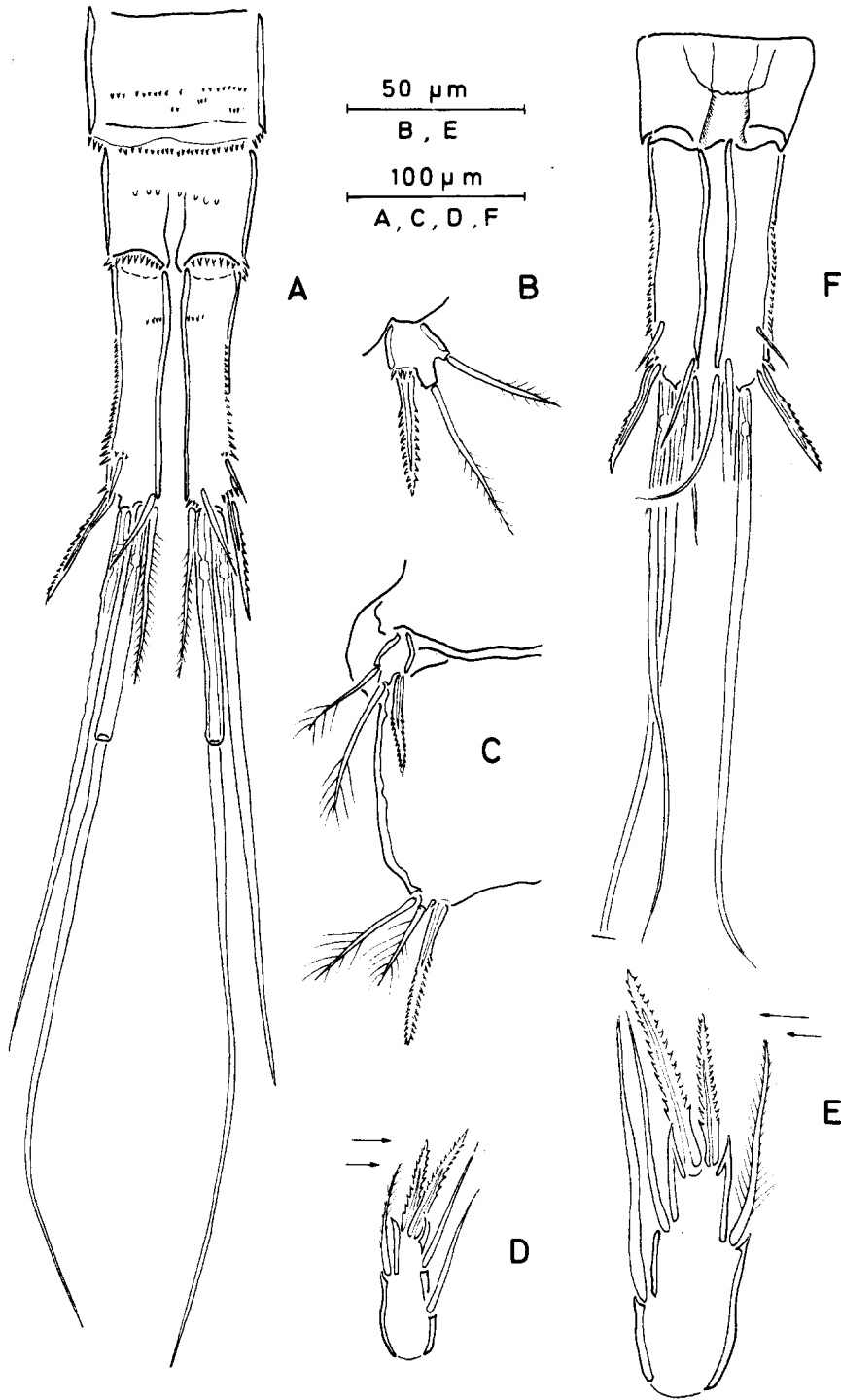
Fig. 4. *Eucyclops s. speratus* Lilljeborg. 1901. A. furca (Jbel Toubkal); B. P₅♀; C. P₅ and P₆♂; D. En-
dopodite 3 of P₄ (Dayat Ifrah); E. Endopodite 3 of P₄ (Jbel Toubkal); F. Furca (Dayat Ifrah).

Fig. 5. *Eucyclops speratus ifniensis* subspec. nov., ♀. A. furca; B. Endopodite 3 of P₄; C. Genital segment with P₅ and receptaculum seminis; D. ultimate segments of first antenna.

Fig. 6. *Afrocyclops g. gibsoni* (Brady, 1904). A. Furca (♀); B. P₄; C. P₅.

Table 1

Afrocyclops gibsoni (Brady, 1904)

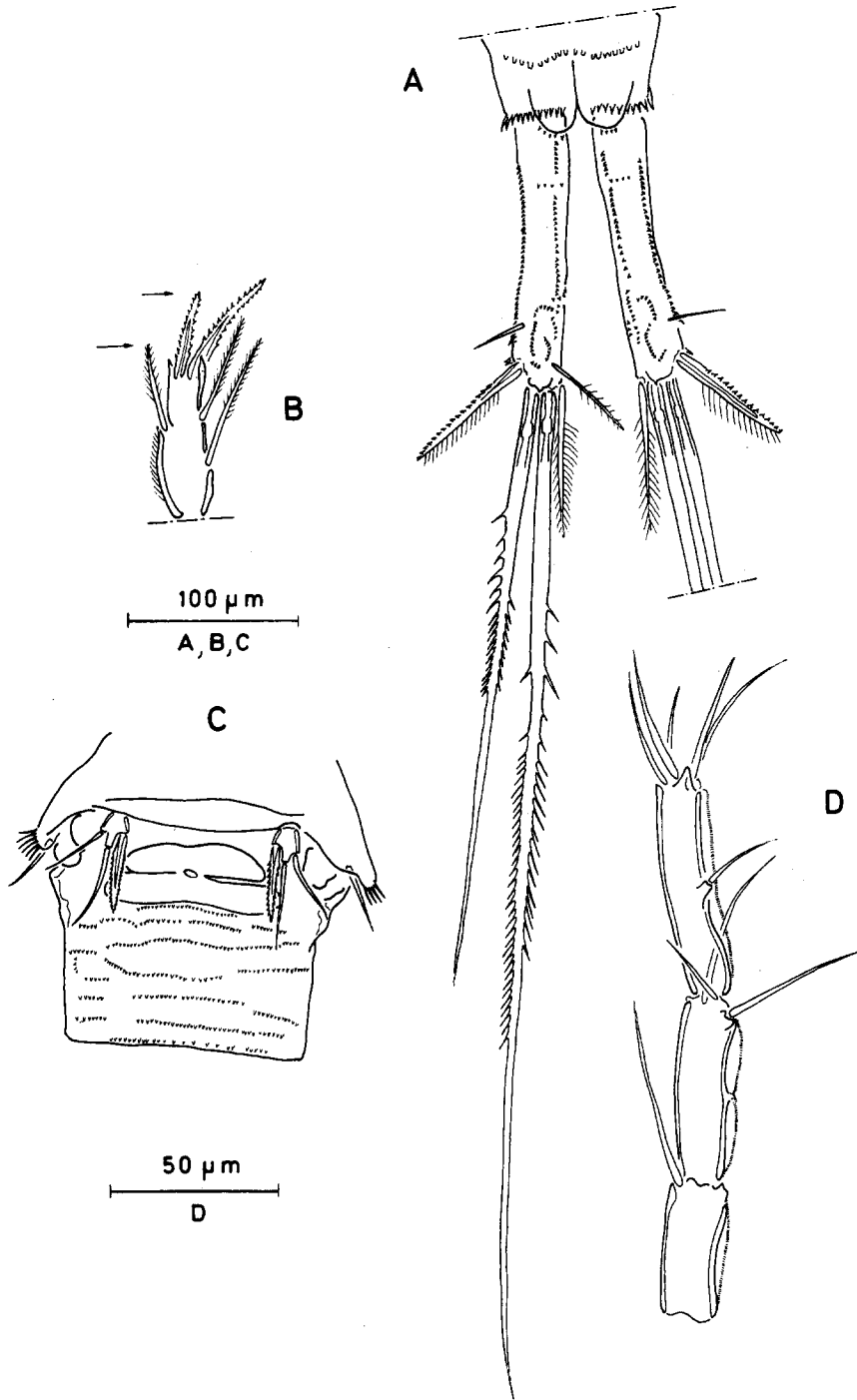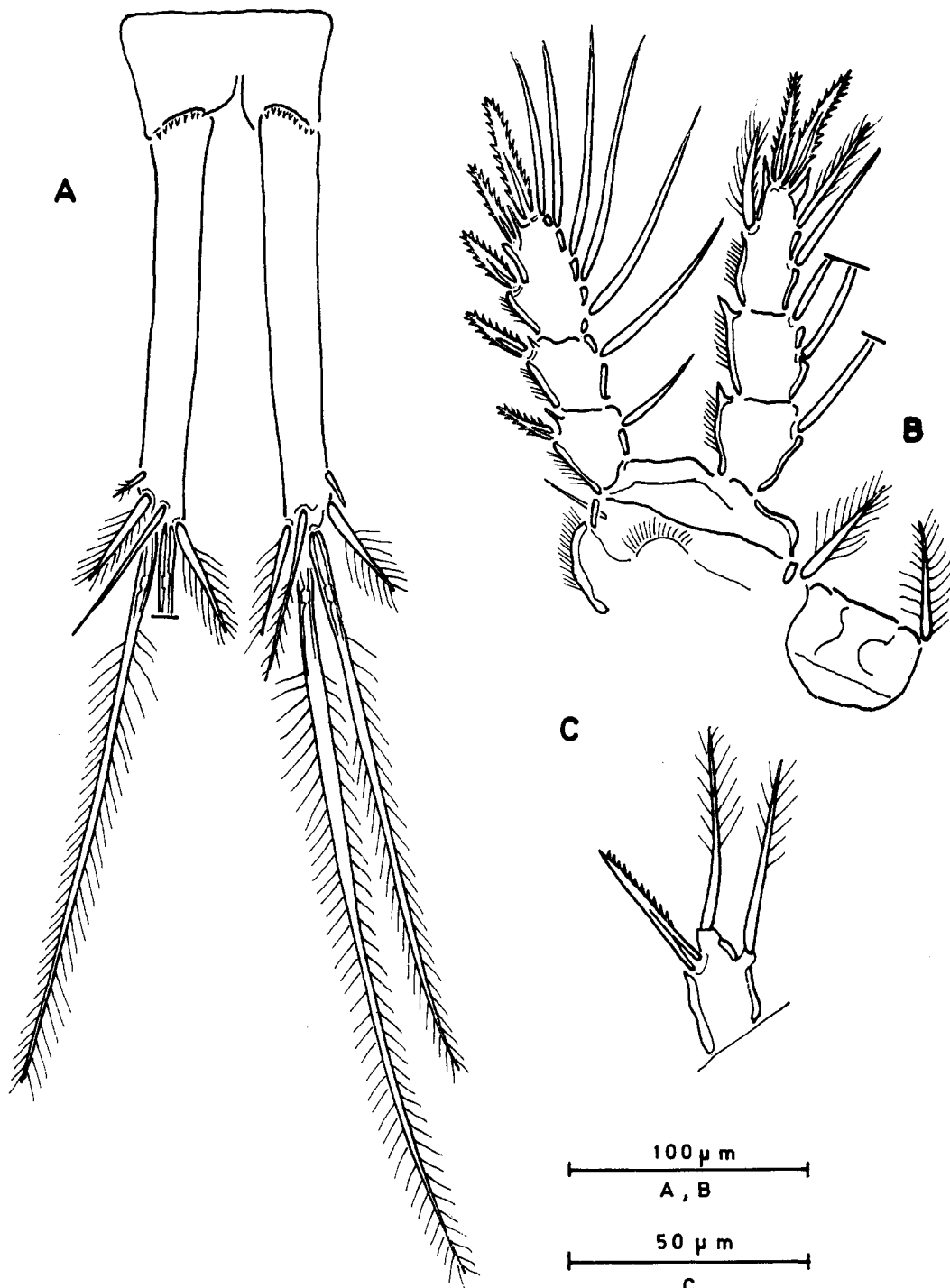|	tot. length (mm)	length furca	width furca
1 ♂	0.84	0.10	
2 ♂	0.87	0.12	
3 ♂	0.86	0.11	0.012
4 ♂	0.86	0.11	0.012
5 ♂	0.91	0.13	0.020
6 ♂	0.96	0.13	0.018
7 ♂	0.87	0.11	0.016
8 ♂	0.98	0.13	0.019
9 ♂	0.89	0.11	0.014
10 ♂	0.88	0.11	0.014
1 ♀	0.91	0.13	0.044
2 ♀	0.94	0.14	0.018
3 ♀	0.91	0.14	0.015
4 ♀	1.01	0.13	0.018
5 ♀	0.94	0.14	0.015
6 ♀	0.90	0.13	0.019
7 ♀	0.98	0.14	0.016
8 ♀	0.93	0.14	0.016
9 ♀	0.89	0.12	0.016
10 ♀	0.89	0.11	0.016

6. *Paracyclops affinis* (G. O. Sars, 1863).
A widespread, though usually uncommon animal, not yet reported from Morocco, but known from Tunesia (Roy & Gauthier, 1927).

7. *Cyclops abyssorum mauritaniae* (Lindberg, 1950).
We now enter the chaos of a Genus which, today, and despite a vast mass of recent information, is almost as ill-understood as about a century ago. The roots of the problem are in the experience of authors that pelagic *Cyclops* s. str. from different origins almost unvariably take a different habitus, but upon structural analysis, turn out to be identical. Kozminski, in a series of papers, the most important of which is Kozminski (1936), has tried to solve the question by morphometry. Following that author, a vast series of new taxa has been created, or old taxa restored.

Splitting has proceeded under Lindberg (1957) and has now resulted, for Europe alone, in a bewildering series of taxa (Dussart, 1969). Particularly desastrous is the complex *strenuus-abyssorum-praealpinus-lacustris*, and it

looks like we shall end up with every lake of some importance having its own 'endemic' *Cyclops*. We shall restrict our discussion to this complex, ignoring some of the better characterized species. One might argue that the Baldi-principle (Baldi, 1951) applies to the case, lakes being, to aquatic animals, more effectively isolated than terrestrial environments to terrestrial animals, and that, consequently, evolution is seen at work. It may, however, and with equal strenght, be argued that we see different environments at work, modeling identical genotypes. If it is felt that the truth must be somewhere in-between, it is evident that the problem of environment *versus* genome is a universal one, which morphologists alone are unable to solve.

What seems most troubling, concerning the complex referred to above, is the lack of pattern in the geographic location of the various 'taxa', there appearing a mosaic-shaped picture. Another reason for doubt stems from the frequent ingnoring of local and seasonal variability. Yet, the latter phenomenon, which may be classified as a particular type of cyclomorphosis, is widespread among Copepoda. In the case of *Cyclops* s. str. it has recently been illustrated by Kiefer & Einsle (1962), Einsle (1967) and, for *Cyclops furcifer* Claus, by Einsle (1963). Variation in time and space proved to be appreciable in all populations studied. A new tool was introduced by Einsle (1962) and is considered by him to be of considerable diagnostic value, i.e. the exact time of the elimination of chromatin from the cell nucleus during the cell cleavage process. Although this criterion has not been attempted on a wide geographical scale, it permits to distinguish between *Cyclops strenuus* and the *Abyssorum* complex (in which is included, at least, the *praealpinus*-group). As Einsle (1964), in laboratory experiments, could not interbreed *Cyclops abyssorum* and *Cyclops strenuus,* there is now sufficient evidence to regard at least these two entities as specific. The first embraces a number of forms mostly found in ponds, i.e. not strictly pelagic (with few exceptions), the second including most of the pelagic forms of alpine and subalpine lakes.

A further point to be discussed is the use that is made of mathematics, and the way in which numerical data are interpreted. First, frequent use is made of indexes. Although useful in a crude evaluation of proportions, indexes have the shortcoming to be unfit for statistical treatment. Second, formal statistical treatment has not yet been applied in the study of *Cyclops*. Third, statistical differences (or any significant differences) between samples refer to differences between populations, not

between taxa. In other words, statistical differences between *Cyclops* from different lakes, are no proof of these lakes having their own endemic 'subspecies'. By qualitative reasoning and the evaluation of temporal variation, before all in members of the *C. abyssorum*-complex, Einsle (several papers) has arrived at a similar conclusion.

With all this in mind and returning to Moroccon populations, *Cyclops* s. str. (sub *C. strenuus,* until Lindberg, 1957) has been reported from the following localities: Aguelmane Sidi-Said (altitude 1600 m; depth 3 m); Aguelmane Azigza (alt. 1800 m; depth 33 m); Lake Tislit (alt. 2200 m; depth 20 m). Aguelmane Azigza is the type locality for *Cyclops abyssorum mauritaniae*. All moroccon mountain records (not those from the coastal plain) should be transferred to that species.

Our discussion of the status of Moroccon populations is based on material from Dayat Ifrah (alt. 1700 m; depth 10 m), Aguelmane de Sidi Ali (alt. 2100 m; depth 35 m) and Lake Ifni (alt. 2400 m, depth 65 m).

Lindberg's (1950, 1957) description of *C. abyssorum mauritaniae* is accompanied by a wealth of indexes. One absolute measure (total length of females) is represented (mean and range only). This is a meager base to rely upon, the more so as the range in Lindberg's data is enormous (1558-2213 μm) and suggests some artefacts in the specimens.

From Dayat Ifrah, we could isolate only one adult, ovigerous female (Fig. VII). This again is extremely meager. The one specimen suggests a more robust form than the animals from Aguelmane de Sidi Ali, with shorter furcal rami and a more elevated number of eggs per ovisac (about 30).

The population from Aguelmane de Sidi Ali shows a habitus which is close to that of Lindberg's type material, being slenderly built (not robust, as stated in Dussart, 1969). The number of eggs per ovisac is about 11 (mean). The population from Lake Ifni, although largely in the final copepodite instars (Dumont *et al,* 1973), yielded enough adult females for comparison. (Table III). The mean number of eggs per ovisac was about 4.

Measurements were taken on the specimens, taking care not to damage them during transfer. The slightest pressure may indeed bring about considerable changes in proportions (e.g. the specimen figured in Fig. 8, D: the lateral expansions of the fourth thoracical segment are completely destroyed by a slight dorso-ventral pressure. These expansions, in the remainder look exactly as in Fig. 8, A).

Deformations may, however, not be completely avoided, and such artefacts may produce departures from the supposed normal distribution of the characters measured. Therefore, it seemed advisable to use a parameter-free test, the Mann-Whitney or U-test. Paired series of observations (n_1, n_2) are first ranked in increasing order and summed (R_1, R_2).

The value for U is then calculated as follows:

$$U_1 = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - R_2$$

$$U = \frac{\left| V_1 - \frac{n_1 n_2}{2} \right|}{\sqrt{\frac{n_1 n_2 (n + n + 1)}{12}}}$$

Observed values for U can be tested for significance against Student's t for $V = \infty$, i.e. 3.29 at the 0.01 level of significance. All values exceeding that figure refer to a significant difference between the entities measured. The calculated values for U are entered in Table II. It is seen that, in all cases, significant differences are present, the animals from Lake Ifni being smaller than those from the Aguelmane. As stated above, this result has no impact on possible taxonomic differences. Not only the chemical and physical environments in which both populations live, but also their biological environments are too different.

As shown by Dumont *et al,* 1973, the plankton spectra of the Dayats of the middle Atlas and including Aguelmane de Sidi Ali are closely related, if evaluated by information (diversity) indexes, reflecting the degree of complexity of the ecosystem. Lake Ifni, conversely, has a low diversity index and a very simple pelagic plankton, in which *Cyclops abyssorum* is the only Copepod species present. Therefore, the principle of interspecies-competition with correllative character-displacement (Hutchinson, 1951) should here be considered.

It cannot be argued that the middle Atlas animals are larger because the conditions of their biotope are less extreme than in Lake Ifni. In the latter lakes, *C. abyssorum* has to respond to the challenge of potential competitors, among which *Mixodiaptomus laciniatus atlantis*. Therefore, its superiority in size and in number of eggs produced per female might well be, at least in part, a mechanism of adaptation.

Competitive stress on *C. abyssorum* in Lake Ifni is virtually absent. In this perspective, its smaller size and the extremely low number of eggs per female might find a logical explanation.

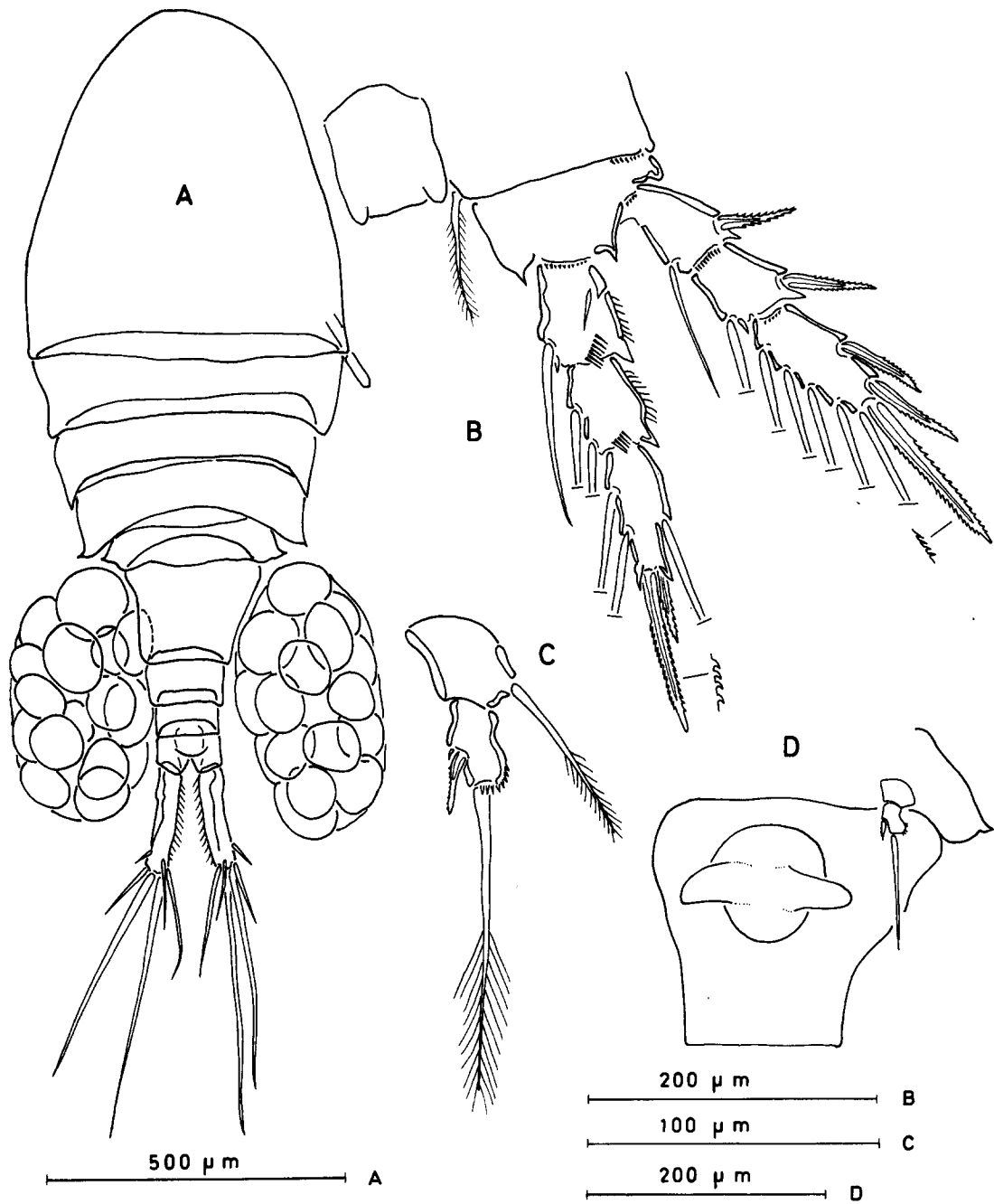Fig. 7. *Cyclops abyssorum mauritaniae* (Lindberg, 1950) from Dayat Ifrah. A. Habitus; B. P₄; C. P₅; D. genital segment with receptaculum seminis.
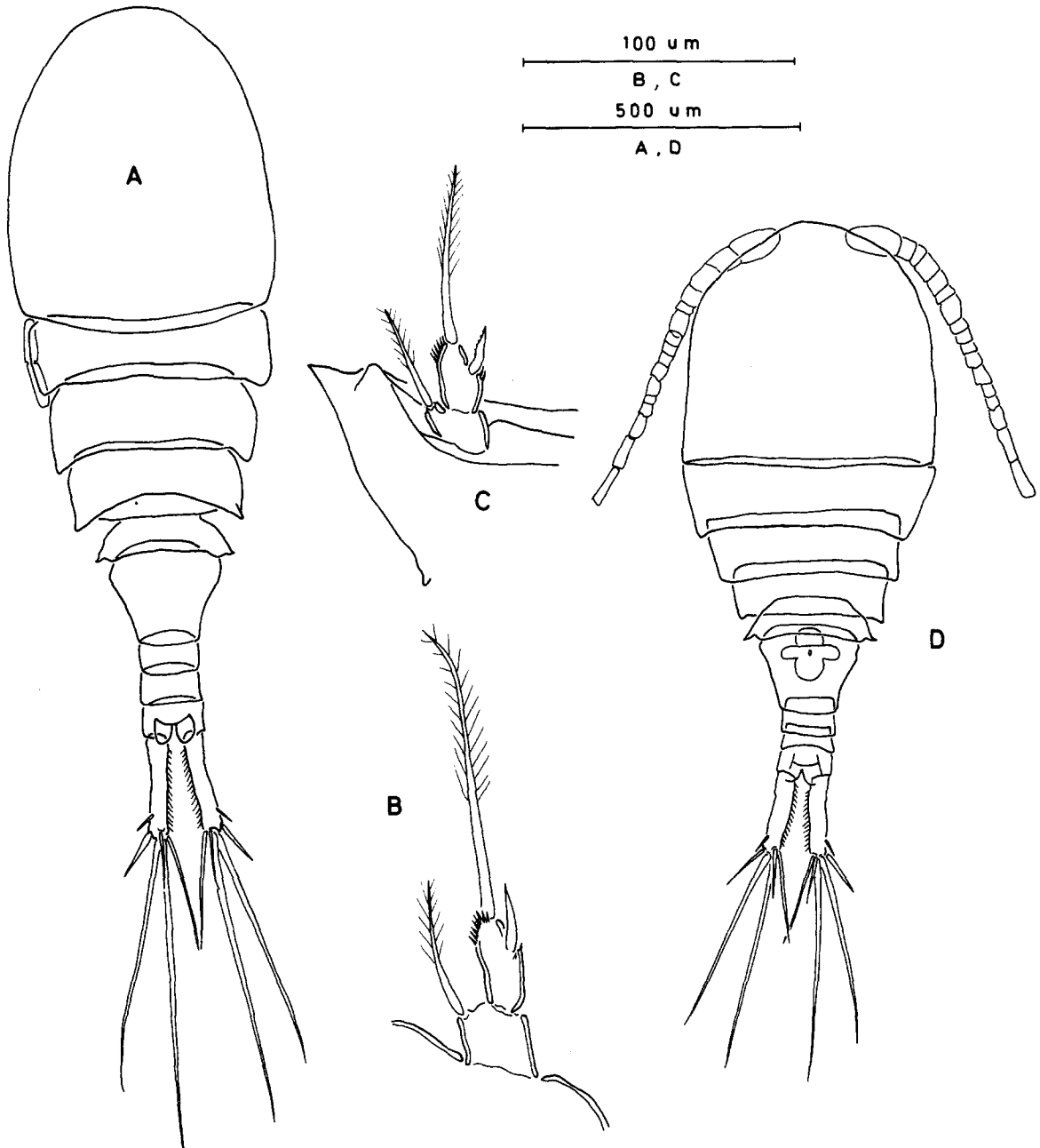
Fig. 8. *Cyclops abyssorum mauritaniae* (Lindberg, 1950). A. habitus of ♀ from Aguelmane de Sidi Ali; B. P₅ of
the same; C. P₅ of female from Lake Ifni; D. Habitus of female from Lake Ifni.

Table 2

Cyclops abyssorum mauritaniae Lindberg, 1950

	Aguelmane de Sidi Ali						Lake Ifni							U
	1	2	3	4	5	6	1	2	3	4	5	6	7	
Total length (mm)	1.41	1.63	1.58	1.67	1.64	1.74	1.24	1.29	1.23	1.23	1.28	1.32	1.29	5.3
Length genital segment	0.18	0.23	0.20	0.18	0.20	0.20	0.155	0.16	0.14	0.17	0.18	0.16	0.175	5.8
Width genital segment	0.19	0.20	0.20	0.20	0.21	0.20	0.18	0.17	0.16	0.165	0.165	0.18	0.17	5.8
Length cephalothorax	0.57	0.61	0.60	0.62	0.63	0.61	0.46	0.47	0.46	0.44	0.46	0.47	0.51	5.4
Width cephalothorax	0.54	0.58	0.63	0.50	0.56	0.49	0.45	0.38	0.42	0.40	0.42	0.42	0.42	5.5
Length Furca	0.18	0.21	0.20	0.19	0.20	0.20	0.15	0.135	0.14	0.135	0.14	0.14	0.14	5.8
Width Furca	0.025	0.025	0.025	0.025	0.025	0.030	0.035	0.03	0.03	0.03	0.03	0.03	0.03	5.9
Length seta externa	0.08	0.08	0.08	0.085	0.10	0.10	0.09	0.085	0.09	0.09	0.095	0.09	0.085	5.6
Length seta medialis externa	0.46	0.49	0.45	0.48	0.47	0.47	0.36	0.34	0.33	0.335	0.35	0.345	0.34	5.5
Length seta medialis interna	0.57	0.59	0.54	0.58	0.60	0.56	0.42	0.38	0.39	0.395	0.41	0.40	0.41	5.8
Length seta interna	0.20	0.20	0.21	0.17	0.21	0.22	0.17	0.15	0.155	0.155	0.17	0.16.	0.145	5.9
Length seta dorsalis	-	-	-	-	-	0.12	0.09	0.075	0.085	0.080	0.09	-	-	-

In conclusion, it is proposed to apply the name, *Cyclops abyssorum mauritaniae* (Lindberg, 1950) to all pelagic *Cyclops* s. str. that occur in the Atlas mountain range, and to regard this subspecies as a genetic entity of local geographic nature and with considerable morphological plasticity.

8. *Thermocyclops schuurmannae* Kiefer, 1928: Fig. 9. Syn. nov. *Thermocyclops infrequens* Kiefer, 1929.

This is the first representative of a Genus of thermophilic, pelagic species, that has numerous representatives in Africa South of the Sahara, and only a very few in Europe. The scarcity of Thermocyclops in Europe, on the geological time-scale, may be a recent phenomenon and of presumed Quarternary age. During the pluvials, African populations had an opportunity to advance to the North, but were stopped by the cold climate of Europe, while during interpluvials most tropical species retreated South, and only few could settle in Europe. Due to their pelagic nature, very few colonies could survive in the Sahara, but Morocco is an exception. It is the only country in North Africa that has a reasonable number of permanent freshwater lakes, and .some of these are situated at low altitude, i.e. in a warm subtropical climate. Thus, Morocco is a key point where one can expect to find an amalgame of species. This fact was confirmed by the discovery of tropical *Thermocyclops schuurmannae* (Lindberg, 1952) and European *Thermocyclops oithonoides* (Kiefer, 1954).

The identity of Moroccon *Thermocyclops schuurmannae* has been a stumbling-block to us, there being, at the outset, some reasons to regard it as *Thermocyclops infrequens* Kiefer, 1929. Therefore, a review of the pertinent literature sources is unavoidable. *Thermocyclops schuurmannae* was described by Kiefer (1928) from an unspecified water-body near Johannesburg (South-Africa). It was added that the species also occurs in East-Africa. Shortly thereafter, *T. infrequens* was described (Kiefer, 1929) from a pond (Brakpan) in Transvaal, South-Africa equally. In his early key, Kiefer (1930) separated both species on evidence of figures of the receptaculum seminis in the female. The differences invoked are, however, so slight andsubjective that it may seem impossible to use them. Considerable overlap is moreover evident from figures that were published later (Kiefer, 1928, 1929a, 1929b, 1956; Einsle, 1970, 1971). In recent keys (Einsle, 1970), the rec. sem. is not used as a diagnostic character.

In the early 1950's, Kiefer (1952), on evidence of new material, remodeled his early work and, well aware of the intricate cluster of forms that live in Central Africa, tried to elucidate the status of several difficult species-groups, among which the *infrequens*-groups, using morphometry. A long series of new subspecies was created, but nothing was said on the relationship between *infrequens* and *schuurmannae*.

Einsle (1970) recently tackled the problem anew, making a valuable effort to bring order and establish relationships. Morphometry was again amply used. A key, separating *infrequens* and *schuurmannae,* was appended. Not having been able to examine any populations of *infrequens* ourselves, we shall define the species, on authority of Kiefer and Einsle, as follows: furcal index 2.5; set. med. int. furca ca. 320‰ of the body length. *T. schuurmannae* is defined by: furcal index ca 3.0; set. med. int. furca about 400‰ of body length.

Numerical data on *T. schuurmannae* are, as far as we know, limited to Lindberg (1952): Barage Cavagnac, Morocco; Lindberg, 1951: Lake Tanganyika and Einsle (1970): Katanga. These are the basis of our discussion (Table III).

From Table III it appears that the relative length of the furcal setae varies tremendously, well exceeding the range that should separate the species pair, and especially at the lower end. Further, a seasonal variation seems to exist in Moroccon populations: Lindberg's February populations were about halfway between 'true' *schuurmannae* and *infrequens;* our August material is completely out of all previously known ranges. If such a cyclomorphosis exists, no diagnostic use can be made of the characters involved.

The furcal index appears somewhat more stable, although Lindberg's figures are ambiguous too.

We consider this to be unsufficient evidence to maintain the name *infrequens,* at the specific level. This is further corroborated by the geographic distribution: both 'species' share the same area but have never been found together.

It is concluded that only one species should be distinguished, which is to be called *Thermocyclops schuurmannae* (Kiefer, 1928). It is a plastic species and all remarks made on *Cyclops abyssorum mauritaniae* apply to the case.

9. *Thermocyclops dybowskii* (Landé, 1890).
First reported from Morocco by Dumont *et al.* (1973). It is widely distributed in Europe and Asia, and it has an African counterpart in *Thermocyclops schmeili* (Poppe
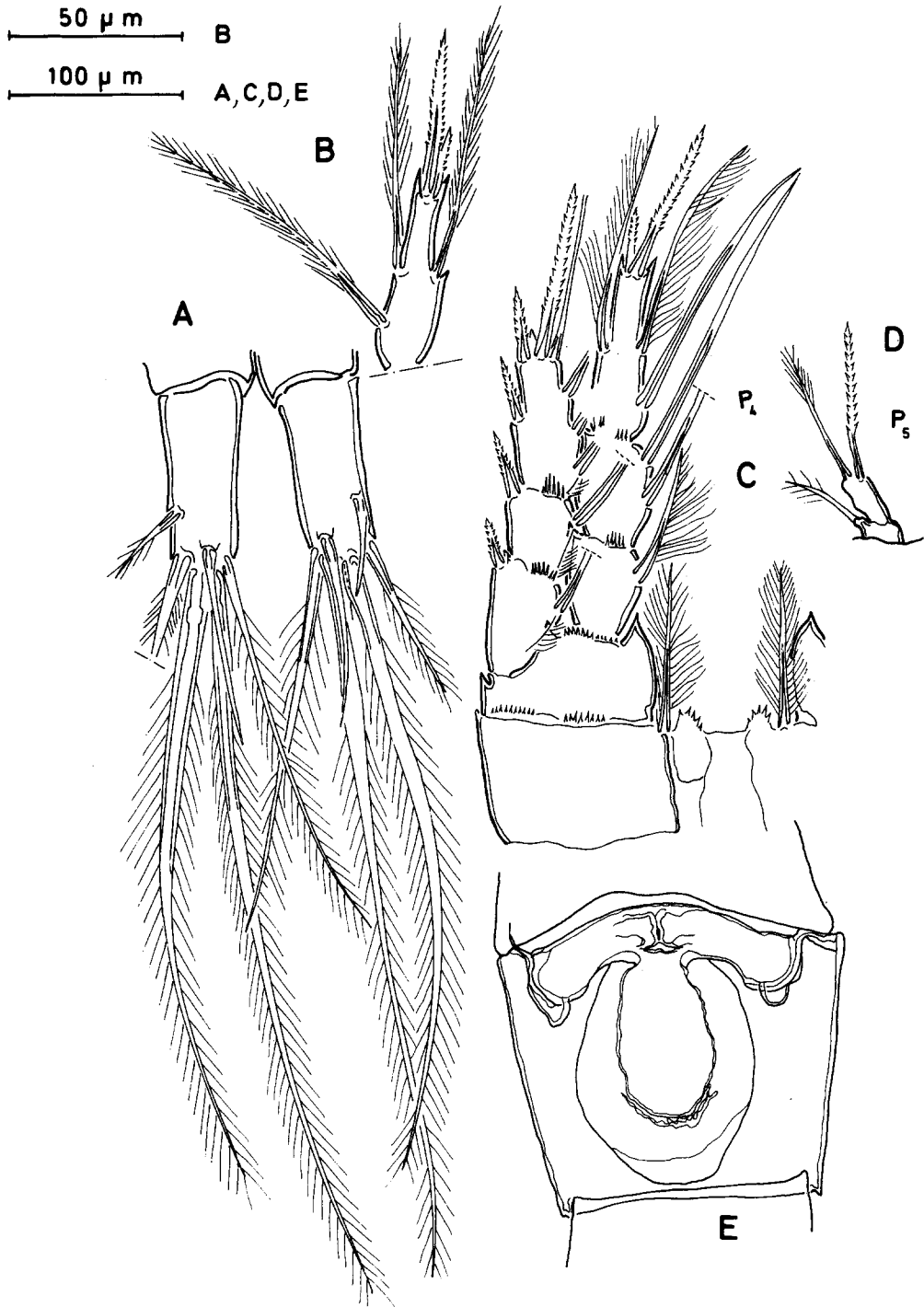
Fig. 9. *Thermocyclops schuurmannae* Kiefer, 1928. A. Furcal rami; B. Endopodite 3 of P₄; C. P₄; D. P₅:
E. receptaculum seminis.

Table 3

Thermocyclops schuurmannae Kiefer, 1928

|	Barrage Cavagnac, August 1971					Barrage Cavagnac February (LINDBERG)				Zaire (EINSLE, 1970)		Lake Tanganyica (LINDBERG, 1951)						
	1	2	3	4	5	1	2	3	4	1	2	1	2	3	4	5	6	7
Total length (µm)	880	1009	904	971	839	988	950	1064	1007	871	897	959	959	931	940	893	950	912
Length furca	64	65	60	62	56	72	70	75	68	82	81	67	72	63	63	60	63	63
Width furca	21	23	21	19	19	25	25	26	26			21	23	22	20	19	22	22
Furca : L/W	3.0	2.8	2.9	3.3	2.9	2.9	2.8	2.9	2.6	3.0	3.05	3.2	3.1	2.9	3.1	3.2	2.9	2.9
Seta externa	67	73	58	62	56	75	73	83	77			68	67	58	67	58	67	57
Seta interna	154	158	130	146	–	200	187	200	200			150	149	142	150	147	153	143
Seta medialis externa	211	227	196	198	–	267	247	279	280			245	237	245	242	234	–	237
Seta medialis interna	235	260	227	215	–	337	325	376	380			340	329	329	350	342	–	350
Endopodite 3, P$_4$																		
Length	63	54	54	60	52	75	70	77	75			70	68	72	72	70	73	68
Length spina interna	56	68	50	60	48	70	57	67	65			53	52	52	53	54	53	52
Length spina externa	25	31	23	33	23	33	32	33	38			27	28	28	28	25	28	25
Seta medialis interna : °/oo of body length	269	257	251	221	–	341	342	363	377	435	440	355	343	351	371	395	–	385

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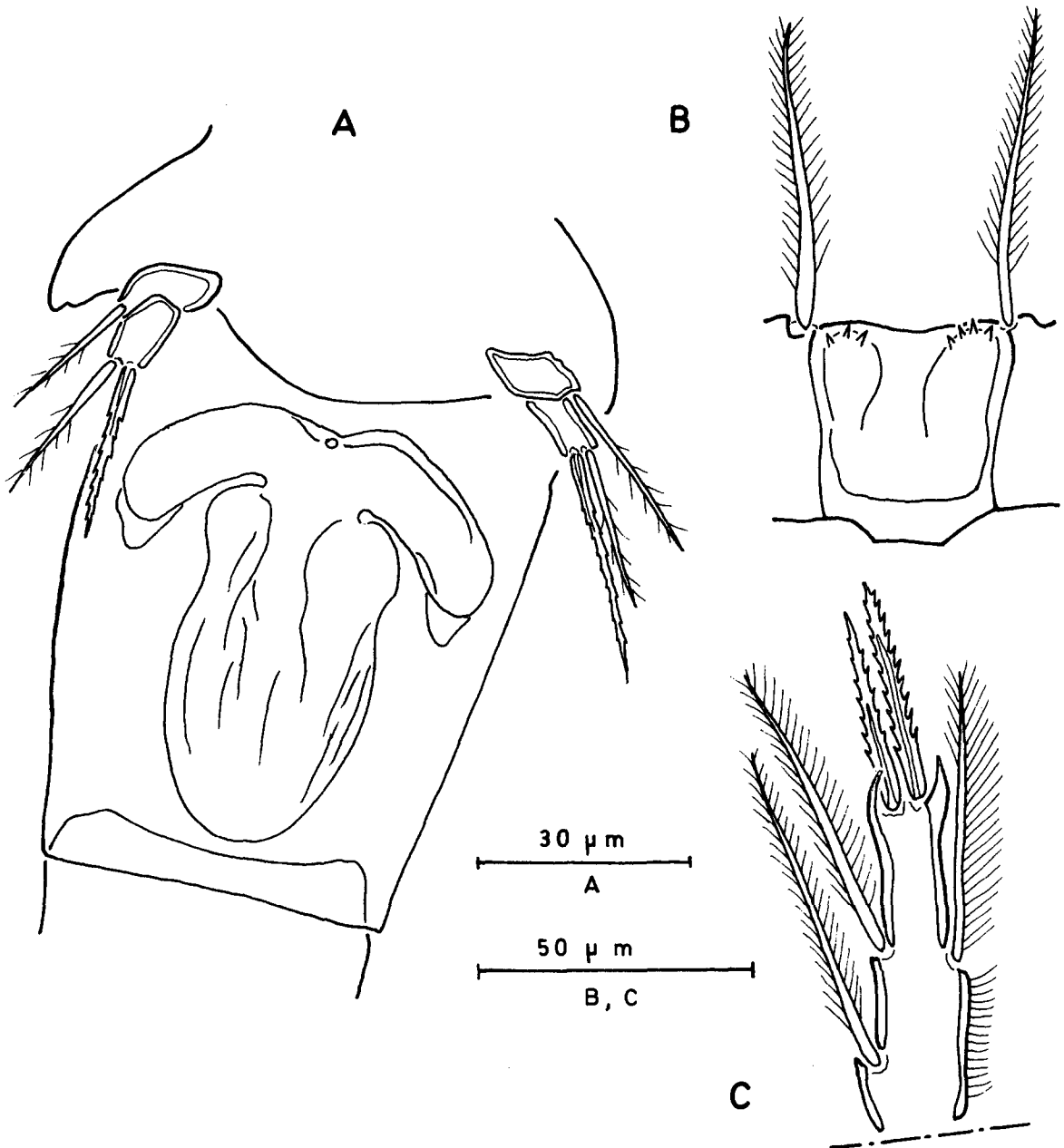
Fig. 10. *Thermocyclops dybowskii* (Landé, 1890). A. genital segment with P₅ and receptaculum seminis; B. P, inter-coxal plate; C. Endopodite 3 of P₄.

table 3 (continued)

Thermocyclops dybowskii (LANDé, 1890) Aguelmane de Sidi Ali				
	1₂	2	3	4
Total length (μm)	835	880	980	865
Length furca	62	70	75	65
Width furca	20	22	25	22
Furca : L/W	3.1	3.1	3.0	3.0
Seta externa	47	54	48	47
Seta interna	85	90	88	80
Seta medialis externa	160	175	190	170
Seta medialis interna	210	235	245	220

& Mrazek, 1895). The latter is considered by Einsle (1970) as a very close relative, and possibly a conspecific of *T. dybowskii*.

This species varies a great deal in size: Löffler (1961) reports extremely small animals from the arid regions of Iran (total length 670-710 μm; furcal index 2.5-2.7). Moroccon Atlas specimens are larger (Table III) and have a furcal index of about 3.0. The name *Thermocyclops schmeili* applies to a robust animal, with furcal index about 4.0. Although Einsle is probably correct in his assumptions on this animal, no overlapping variability has to date been brought on record. Therefore, untill further evidence, a synonymisation should be delayed.

It is noteworthy to recall that in Aguelmane de Sidi Ali, two different species of *Thermocyclops* live. *Thermocyclops oithonoides* Sars has been found here by Kiefer (1954: figs.).

10. *Bryocamptus zschokkei* (Schmeil, 1893).
This is a widely distributed monticolous species, that has been recorded from all important mountain ranges in Europe and Asia. Its presence in the Atlas mountains, at an altitude of 3200 m, is therefore quite natural.

11. *Onychocamptus mohammed* (Blanchard & Richard, 1891).
A species characteristic of continental saline waters, with a wide distributional range. Although it was first described from Algeria, it had never been found in Moroc-

co. Its occurrence in saline pools in the bed of the River Ziz could, however, easily have been predicted.

12. *Cletocamptus retrogressus* (Schmankevitch, 1875).
This is another species typical of continental saline waters. The biotope in which it was found in Morocco is part of a series of pools, ranging from almost pure freshwater to hypersaline swamps. Our samples came from a brackish environment, as proved by the accompanying Cladoceran and Insect fauna. *C. retrogressus* was first found in North Africa by Richard (1889) and later again by Gurney (1909). Both records refer to the Algerian territory. The occurrence of *C. retrogressus* in Morocco is thus not surprising.

13. *Nitrocella ioneli* Dumont & Decraemer, 1975.
From a saline cemented source in the hamada between Rissani & Merzouga (loc. 16), a long series of *Nitocrella* was obtained, that could not be identified with any of the known species of the genus. It was therefore described as a new species (Dumont & Decraemer, 1975).

Conclusive considerations

The fact that, despite authorative previous work, one single journey to Morocco could suffice for bringing on record 10 copepod species new to that country and two new to science, proves that its fauna remains very imperfectly known. We are relatively best informed on the Calanoida. Great richness in species exists in the coastal plain. An almost certain further addition here will be *Copidodiaptomus numidicus* (Gurney, 1909), described from Algeria and also found in Southern Spain (Kiefer, 1968).

Among Cyclopoida, the most widespread species are *E. serrulatus* and *T. prasinus*. Both are of worldwide occurrence. When going over the list of Cyclopids, one is struck before all by a number of abscences: there is scarcity in *Eucyclops*-species and the genera *Microcyclops, Cryptocyclops, Mesocyclops* and *Speocyclops* are at all absent. Yet, most among these are known from adjacent countries, thus they might also live in Morocco. About the Harpacticoid fauna, one may say that it is almost undocumented and that numerous surprises may be expected in the future.

On the other hand, and as stated before, Morocco appears as a boundary where fauna's of very different origin meet. It is the limit of southern extent for the genus
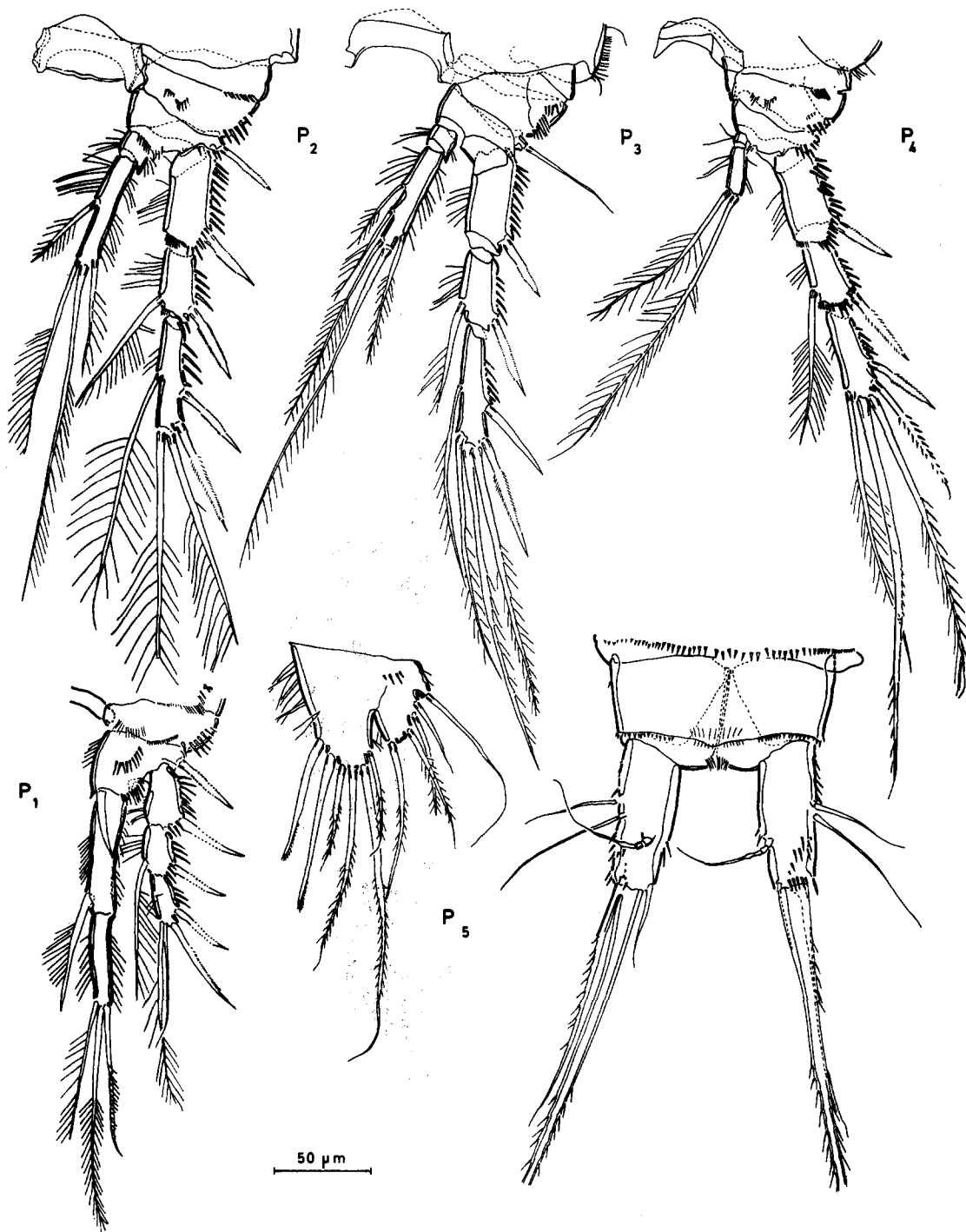
Fig. 11. *Cletocamptus retrogressus* (Schmankevitch, 1875). The structures shown are identified on the figure, except the furcal area.

Cyclops s. str. and this group of mostly cold stenothermic animals probably spread along the mountain ranges of the tertiary alpine fold. It is also the limit of northern extent of warm stenothermic species, such as *Afrocyclops gibsoni* and *Thermocyclops schuurmannae*. The reason for this phenomenon has been discussed already. Importantly, one may suspect (although proof is difficult to give) that all these categories are in the process of taxonomic diversification. Their isolation appears, however, not to have lasted long enough to allow us, using the tools of todays taxonomy, to place them in objective categories.

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