ON THE CONSTRUCTION OF SIMPLIFIED KEYS FOR THE DETERMINATION OF ZOOPLANKTON IN RADIOECOLOGICAL AND PRODUCTION STUDIES

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In order to follow the path of radioisotopes from sea water through the marine food chain to fish used as food for man, it is necessary to establish the existing food relationships within the community of marine organisms. This aim can only be achieved when we know which organisms are present and in what numbers. Ideally, each species present should be counted separately, for even within a morphologically fairly uniform group like the copepods there are herbivorous, omnivorous and carnivorous species which play quite different roles in the accumulation and transfer of radioactive substances.

For most zooplankton groups, keys for determination exist; for Mediterranean species see ROSE, 1933; MASSUTI and MARGALEF, 1950; TRÉGOUBOFF and ROSE, 1957. These keys are generally efficient, but have the disadvantage that working with them is a very laborious procedure and may require specialized knowledge. For instance, in order to determine copepods correctly with the existing keys, it is necessary to dissect the animals under the preparation microscope, since these keys make use of subtle morphological characters such as the number of segments of endopodite and exopodite, the number of setae of a specific exopodite segment, etc. In practice, it is often difficult to count even the legs without dissection. Since the determination of the various species is so time-consuming, they are frequently sent out to specialists or lumped together as « copepods ». The latter procedure may be justifiable when one species is dominant and constitutes 80 % or more of the total copepod biomass (e.g. often *Calanus finmarchicus* in northern seas), but in the Mediterranean, where single species dominance is rare, this method should not be applied. It was therefore necessary for the requirements of our program to find easier and quicker ways of accurately identifying the most abundant species.

A specialist is able to identify most of the species by simply looking at them, i.e., without dissection. It can therefore be assumed that certain features must exist which are easily recognizable and which, taken together, could suffice to identify the species. By use of these characters, it should be possible to construct a key which permits one to distinguish the species without going through the tedious procedure of dissection.

It should be noted that such a key does not pretend to replace the traditional keys but would give a simple, rapid and efficient tool to the non-specialist who is concerned with the identification and counting of the principal components of plankton communities. A key of this kind should also be simple enough to be used by the technicians who, in most cases, will perform the actual counting.

In order to facilitate the construction of a key of this kind, it appears to be necessary to depart from some principles to which the traditional keys generally adhere.

1) This artificial key does not follow the pattern of natural relationship. Because most existing keys follow the natural hierarchy down from orders through suborders, families, etc., it often happens that a very conspicuous feature is listed only as the last step after numerous

subtle features had to be checked, although this character (e.g., the shape of the furca of the copepod *Calocalanus pavo*) alone may suffice to distinguish the species. Limiting the key to such conspicuous features will facilitate and accelerate the determination considerably; if information on the position of the species in the natural system is needed, it can be found easily in the literature.

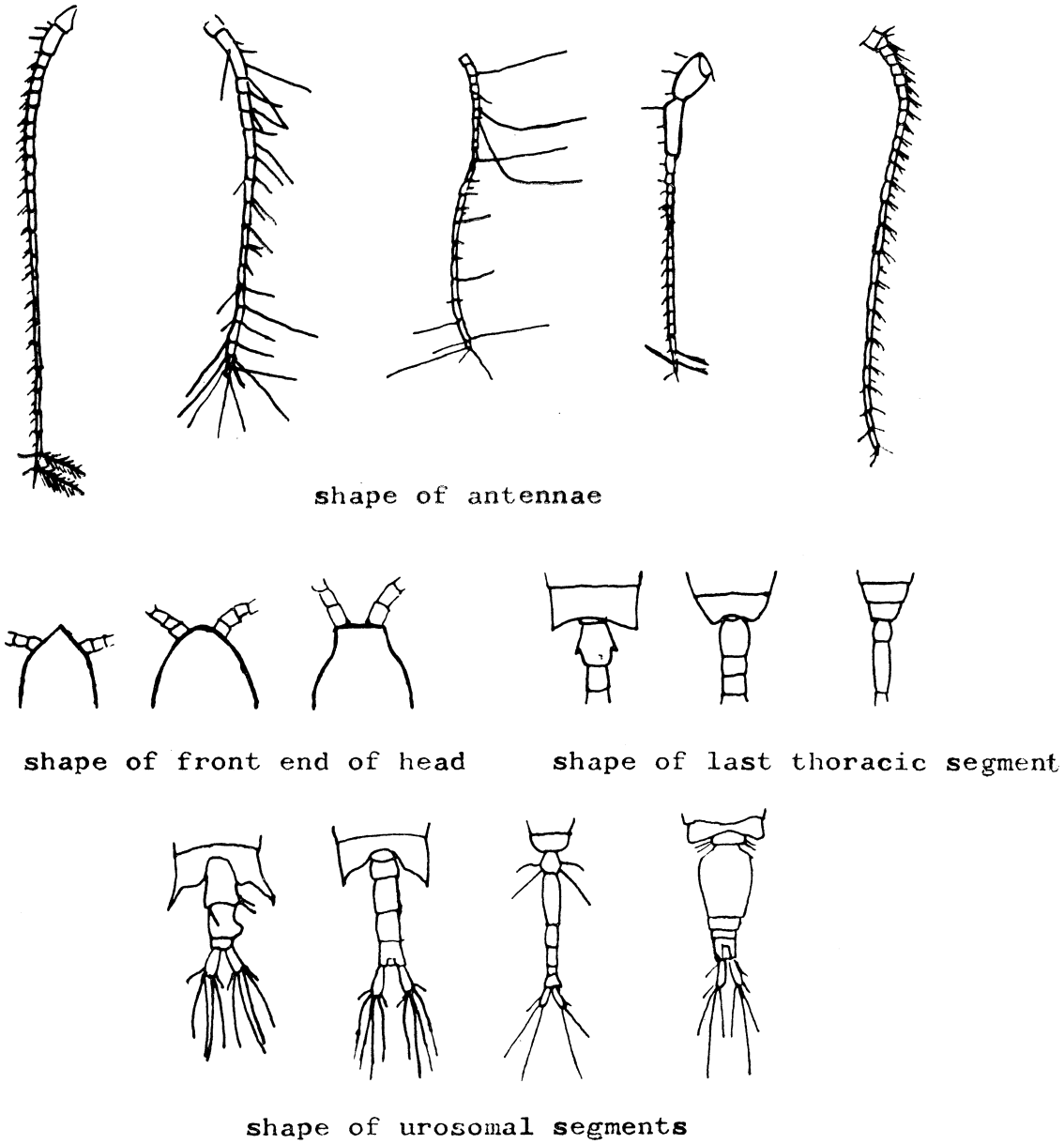

FIG. 1. — *Some features used for the construction of an artificial key for copepods.*

2) Likewise, this key does not provide complete coverage of all known species. This appears entirely justifiable because the rare forms are almost always of negligible importance for the study of production, radioecology and the food chain.

The mistake which might result by erroneously classifying an unlisted rare species together with an abundant species which is listed in the key will not contribute in any appreciable

amount to the total counts. In order to simplify the determination it is therefore advisable to restrict the species covered by the key to the abundant ones.

For copepods, an attempt has been undertaken to construct a key of this type (NEUNES, 1965); it is currently in print. The morphological characters used are : length of first antenna to the body; shape of antennae; shape of front end of head; shape of last thoracic segment; shape of urosomal segment and furca; configuration of furcal bristles and general body contour. In general, these features are not altered in fixation and are easily visible under the preparation microscope; they have the additional advantage that most of them-in contrast to many features used by the traditional keys-remain constant throughout the development through the copepodite stages, so that the key can also be used to identify most copepodites. Figure 1 shows some of the features used for separating the species. Within some difficult genera like *Sapphirina* and *Oncaea* it was not possible to separate the species. A preliminary version of the key has been tested in several laboratories and found to be useful within the limits indicated.

Traditional key. ROSE (1933). The underlined characters require. dissection	Simplified key. NEUNES (1965)
1) Mouth appendages present (vs. absent).	Body subdivised into cephalothorax and urosome (vs. undivided).
2) Chitinous eye lenses present (vs. absent).	First antennae longer than head (vs. shorter).
3) Body round (vs. flat).	Last thoracic segment much wider than urosome (vs. gradually narrowing).
4) Maxillipeds with bristle-like setae (vs. scale-like setae)	Furcal branches not horizontally directed (vs. horizontally).
5) *Number of segments* of endopodites of third and fourth legs.	Head shorter than the body (vs. longer)
6) *Number of segments* of endopodite of first leg.	First antennae at the most as long as the body (vs. much longer than the body).
7) *Number of spines* on the external boards of the exopodites.	Last thoracic segment pointed (vs. rounded)
8) *Number of segments* of second antenna.	Furcal branches very long and narrow (vs. much shorter and wider).
9) *Endopodite of fifth legs* with feathered setae (vs. without).	
10) Furcal branches long and narrow (vs. much shorter and wider).	
11) Last thoracic segment pointed (vs. rounded).	

TABL. 1. — *Comparison between characters used for the determination of the copepod* Temora stylifera (compare fig. 2) *by means of a traditional and a new simplified key.*

Table 1 lists the characters to be checked for the determination of the species *Temora stylifera* (fig. 2), for example, the key by ROSE (1933) being compared with the newly constructed simplified key. With the new key, determination of this species is even possible from the photograph, while six of the eleven characters used by ROSE require dissection. The principles on which the new key is based and which have been listed above, should — with appropriate modifications — also be applicable to groups other than copepods. In Siphonophora, for instance, we are confronted with the problem that the existing keys are based on the anatomy of the whole colony, consisting of numerous, morphologically very different single individuals, while in our plankton samples the colonies are always fractured and we often find nothing but single, bell-shaped individuals. An artificial key is required that makes exclusive use of the features of the single bells. There is a great variety of characters wich could be used : the bell can be round, conical or polygonal; if conical, the apex is flat, rounded or pointed; the bells may or may not have longitudinal ridges and these may be smooth or saw-toothed, etc. The resulting key probably would not reflect natural relationships — especially because of the polymorphism of the individuals constituting a colony — but it would serve to distinguish the important species.

Nevertheless, even with simplified keys based on the principles proposed, the numerical evaluation of plankton samples remains so laborious that it is a limiting factor for the research capacity of many laboratories. It is suggested, therefore, that serious thought be given to finding a way to make use of electronic computers, perhaps employing a scanning and screening device which automatically analyzes our samples. Such an automatic technique might even make possible immediate on-the-spot analyses of plankton samples, thus opening entirely new and valuable possibilities for our research programs. The information which could be used in the computer programs would probably be based on simple morphological characters like those used in the artificial keys proposed in this paper.

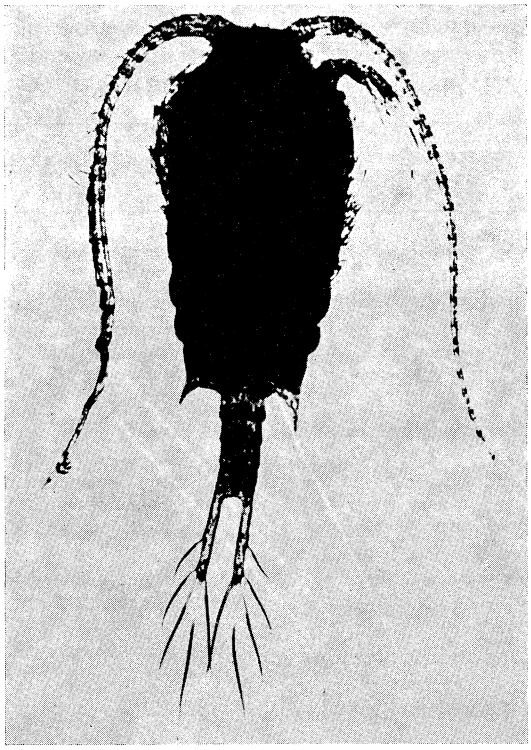

FIG. 2. — Temora stylifera, *mâle*.

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