

# Dispersed scolecodonts from Cainozoic strata of Jamaica

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Scolecodonts found in Cainozoic palynological and palaeontological samples from Jamaica are compared with dispersed scolecodonts from Tertiary strata in France. The problem of delimiting species and genera is discussed in view of the variability observed in Recent polychaete annelids and of the dissimilar populations found in the two regions.

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## Introduction

In February - March 1975 a palynological sampling survey was made in Jamaica, sponsored by the Netherlands Organisation for the Advancement of Pure Research (Z.W.O.) at The Hague, The Netherlands, and it has been provided with excellent transport facilities by the Mines and Geology Division of the Ministry of Mining and Natural Resources of Jamaica. The author is very much obliged to Dr J. P. Krijnen who gave all possible support to this sampling survey and solved the problem of accommodation for the author and his spouse during the seven weeks stay. The Progress Reports on the palynological investigation of the samples are mentioned in the list of references (Germeraad, 1978 - 1979). In a paper on fossil fungi, algae and other organisms (Germeraad, 1979b) appeared a summary on the geology and palynology of Jamaica.

As the scolecodonts described from Palaeozoic strata are different from the Cainozoic Jamaican fossils, contact was taken up with some zoologists at the Rijksmuseum van Natuurlijke Historie in Leiden. Dr J. Krikken was convinced that the Jamaican jaws do not belong to the Insecta and most likely not even to the Arthropoda, simply because they have too many denticles. His colleague Dr L. van der Hammen did not recognize the fossils as arachnid jaws. Dr J. van der Land was inclined to consider most specimens to be jaws of polychaete annelids, a group of animals as yet found only in marine environments.

Further useful information was obtained during the Fifth International Palynological Conference held in Cambridge from 29 June to 6 July 1980. Mrs Marilia da Silva Pares Regali gave a lecture on scolecodonts found in the Eocene and Oligocene of Brazil; the slides showed well preserved fossils with a certain resemblance to some of the types found in Jamaica. The author is very much obliged to Dr R. E. Jan du Chêne who provided him with his – and Gorin's – papers dealing with scolecodonts from the Palaeocene and Eocene of France and Switzerland, and for his permission to reproduce drawings of his illustrations necessary to elucidate some aspects of the comparison of the fossils from France and Jamaica. Additional help and suggestions from Drs P. S. Boyer, E. W. van Erve and J. Jansonius are gratefully acknowledged here.

## Sample localities

Most sample localities have already been indicated on the geological map of Jamaica in Germeraad (1979b, p. 4, fig. 1). Some additional information is given below (K = Krijnen sample, JHG = Germeraad samples).

K74-4: fissure filling in the Palaeocene Chepstow Limestone Formation at Bantimore River, west of Bloomfield, northern Blue Mountain region.

JHG-107: Lower Eocene part of the Richmond Formation at Fruitful Vale.

JHG-333: Lower Eocene part of the Richmond Formation in Dry River, just south of JHG-334.

JHG-374 and 376: Middle Eocene part of the Richmond Formation near Langley, just north of JHG-377.

JHG-384 and 385: Middle Eocene part of the Richmond Formation near Langley, between JHG-377 and 389.

JHG-389 and 390: Middle Eocene part of the Richmond Formation near Langley.

JHG-391: Middle Eocene part of the Richmond Formation near Langley, a few metres south of JHG-390.

JHG-413: Lower Eocene part of the Richmond Formation at the Oracabessa River, west of JHG-408.

JHG-592: Holocene strata at Bowden.

## Habitat

The living polychaete annelids all have their habitat in a more or less marine environment. The small group of protoarthropods, the Onychophora, to which *Peripatus* belongs, are terrestrial animals. In general, the fossil scolecodonts have been found in marine deposits. This is also the case with most of the Jamaican fossils, with the exception of those observed in sample K74-4, discussed below. The remaining types were obtained from marine to brackish sediments of post-Palaeocene age. The large specimen of type JAM. 2123 was picked from the washing residue of foraminifera. It is worth noticing that neither in the Upper Cretaceous and Palaeocene clastic sediments, nor in the carbonate Oligocene-Miocene samples from Jamaica any scolecodonts were observed as yet.

Sample K74-4 needs further discussion: in the Upper Cretaceous limestones collected by Krijnen in the Rio Grande Region many well preserved younger Tertiary and Quaternary pollen grains were found without any foraminiferal remains or marine dinoflagellate cysts. Careful examination of large pieces of these limestones during the exposure to hydrochloric acid revealed the presence of dark organic cakes in the diacalse-fissures (Germeraad, 1979a). No doubt the floras had entered these fissures long after the limestones were folded and had arisen above sea-level. The good preservation of the pollen grains indicates that they had not been exposed to prolonged oxidation, which means that the fissures had been water-filled most of the time. The Palaeocene sample K74-4 contains a few inconspicuous pollen grains and fungal spores, and as an assemblage resembles the palyno-association of the Upper Cretaceous fissure fillings. However, other Palaeocene samples from Claverty Cottage, also in the northern part of the Blue Mountains region, contain young pollen grains in association with foraminiferal remains and marine dinoflagellate cysts, indicative of a marine origin for at least that part of the material. Unfortunately nothing is known about the condition of the overlying cover and of the topography of that region at that time.

JAM. type numbers	2123	2093	2017	2092	2014	2018	2015	2023	2086	2088	2087	2076	2085	2083	2082	2081	2084	2077	2080	2079	2078	2057	
Holocene																							1
Young fissure filling									1	2	1	2	1	2	1	1	1	1	1	1	1	1	
Miocene-Pliocene																							
U. Eocene-Oligocene																							
Middle Eocene				1	1	4	1	2	2														
Lower Eocene	1	1																					
Palaeocene																							
Upper Cretaceous																							

Fig. 1. Distribution chart of dispersed scolecodonts found in Cainozoic strata of Jamaica. Note that the following pairs of types are assumed to be morphologically related: 2093 + 2017, 2014 + 2018, 2023 + 2086, 2087 + 2076, 2082 + 2081, 2084 + 2077, and 2080 + 2079.

## Stratigraphy

The stratigraphic position of the Jamaican scolecodonts is given in the distribution chart (Fig. 1). With the exception of the young fissure filling of sample K74-4 the autochthonous character of the occurrences appears probable for the Eocene material, as it seems likely that fossils reworked from the Upper Cretaceous and Palaeocene strata would not be so well preserved, particularly the tiny denticles would have usually been worn off during the process of erosion and transport.

With regard to the scolecodont assemblage found in sample K74-4, it should be noticed that the organic plant material of practically the same age in the Palaeocene Providence Shales nearby is poorly preserved and rather carbonized; it seems unlikely that the still transparent-brown jaws were not effected by the general low-degree metamorphism. A post-Palaeocene age appears most likely.

One is tempted to assume that the scolecodont jaws found in this sample originated from the erosion of Eocene marine sediments nearby. However, from the limited number of samples examined, no Eocene pollen markers are known to occur in these fissure fillings. As the pollen from the different fissure fillings are indicative only for a long range, from Miocene to Quaternary, it may be assumed that these fissures were not filled all at the same time, but that the process took place in different periods at different places.

## Taxonomy and variability

Most workers on fossil scolecodonts have little doubt about the relationship of them with polychaete annelids. Not so Schwab (1966) who compared them with the jaws and claws of *Peripatus capensis* Grube and found certain corresponding characteristics by X-ray and spectographic analysis. Moreover, there are morphological features that *Peripatus* and some scolecodonts have in common, e.g. the general shape and the arrangement of several denticles behind

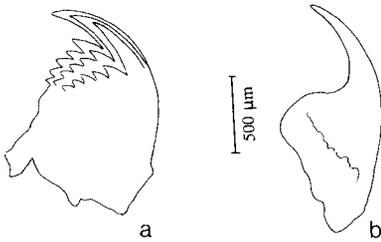


Fig. 2. Inner (a) and outer (b) jaw of *Peripatus capensis* Grube, drawn after Schwab (1966, text-fig. 3D,E). A relationship with some scolecodonts cannot be excluded according to Schwab.

the cusp (Fig. 2). It is evident that the possibility of a protoarthropod origin of some of these fossil remains should not be excluded.

The taxonomic difficulties on the species and genus level have been extensively discussed by Kielan-Jaworowska (1966), Kozur (1970) and Taugourdeau (1978). The greatest concern is caused by the variability which seems to have been highest during the Palaeozoic and may have become considerably less in younger times, but nevertheless appears rather unpleasant for the investigator (Kielan-Jaworowska, 1966, p. 30). Quite exceptional are the observations of Monro (1933, p. 88) who found very little variation in the jaws of half a dozen specimens of the Recent *Arabella novecritina atlantica* Crossland.

In spite of the high variability being widely accepted, many species have been established on dispersed jaws, quite correctly so as there is no clue to which degree of variability related species were subjected. For Tertiary jaws this is even more valid as so little information about the scolecodonts in that period is available. With this in mind the author assumes the presence of some new species in his Jamaican material and thinks the splitting up of the genera *Staurocephalites* and *Anisocerasites* necessary.

#### TERMINOLOGY

In this paper the terminology given as a glossary of descriptive terms by Jansonius & Craig (1971, p. 257 - 261, figs. 1, 2) has been adopted. In addition the author has used two expressions which are not to be considered yet as coined terms, indicating the position of the denticles that are not lying in the plane of the jaw: 'on the inner side of the jaw' is used when the denticles are situated more on that side of the jaw at which the myocoele is also more open; 'the outer side' is the counterpart. The possible taxonomic bearing of this aspect is discussed in the paragraph on the genus *Anisocerasites*.

#### DENTAL FORMULAS

Dental formulas, proposed and discussed by Taugourdeau (1970, p. 1 - 5), Jansonius & Craig (1971, p. 261 - 264), Taugourdeau (1978, p. 14 - 17) have not been used in this paper for two reasons: 1) if the application of such a codification is simple because the jaw has no complex arrangement of the denticles, then the formula can be grasped immediately from adequate illustrations; 2) in those jaws where the denticles are arranged in a three-dimensional pattern (like e.g. in types JAM. 2078, 2085 and 2014) the formula fails to code this conspicuous complexity.

## POSITION IN THE JAW APPARATUS

For the isolated jaws one may search for homologous counterparts in the complete jaw apparatuses. From such studies it may be concluded that the majority of the Jamaican scolecodonts found might be interpreted as MI. It is amazing that so few non-MI's have been observed, with the exception of the 'appendix' of type JAM. 2081 which may be considered a basal plate. Even more astonishing is the 'twin-set' in parallel position of sinistral MI's coded type JAM. 2083. As the difference between the two jaws is restricted to the proximal part — the myocoele is more developed in the jaw on the right hand side — would this mean that in this case an MIs is accompanied by a similarly shaped more anterior jaw of the same apparatus?

As regards the *Anisocerasites* group, the assumption of the presence of so many MI specimens together is in striking contrast with the conclusion of Kozur (1970, p. 39) that they probably should be considered to be 'vordere Zähne, wie sie bei den verschiedensten Eunicida auftreten können'.

## Descriptions

*Staurocephalites* Hinde, 1879 (Fig. 3)

The definition of Hinde (1879, p. 383) is short and refers to the Recent genus *Staurocephalus* Grube. All later comments agree on the characteristic feature that one row of denticles, slanting backwards and decreasing in size in posterior direction, is present on the jaw. Occasionally a species (e.g. *Staurocephalites alterostris* Eller, 1955, pl. 5, figs. 1, 2) shows one second order denticle immediately behind the first anterior first order one. This may be considered as the beginning of a development which in the Tertiary resulted in a more or less complete series of alternating first and second order denticles: a few intercalated second order denticles have been observed in several but not all specimens of *Staurocephalites taugourdeausi* Jan du Chêne (a few in Jan du Chêne & Gorin, 1974, pl. 2, fig. 1; pl. 6, fig. 1; none in Jan du Chêne, 1975, pl. 1, fig. 8), many in almost the complete series in *S. broennimanni* Jan du Chêne & Gorin (1974, pl. 6, figs. 3, 4; Jan du Chêne, 1975, pl. 1, figs. 5, 7). A specimen also attributed to *S. broennimanni* by Jan du Chêne (1975, text-fig. 2) has second order denticles in groups of two or three between the first order ones. One might regard these features as intrinsic to the great variability of the species and genus, but from the stratigraphers point of view such 'lumping' should take place only after a period in which the 'splitting' has failed to give consistent taxonomical and practical results. It is the author's opinion that this stage has not been reached.

Another, fundamentally different 'lineage' is the development of two rows of denticles, with the rows either diverging as in *S. longirostris* Eller (1964, pl. 5, figs. 11, 12), or in closely parallel position as in *S.* sp. of Schwab (1966, pl. 54, figs. 2, 3) and in type JAM. 2085. According to Schwab the specimen of fig. 2 shows a secondary denture that occupies the fossa of the primary jaw. In two other specimens he observed two sets of jaws, one closely set

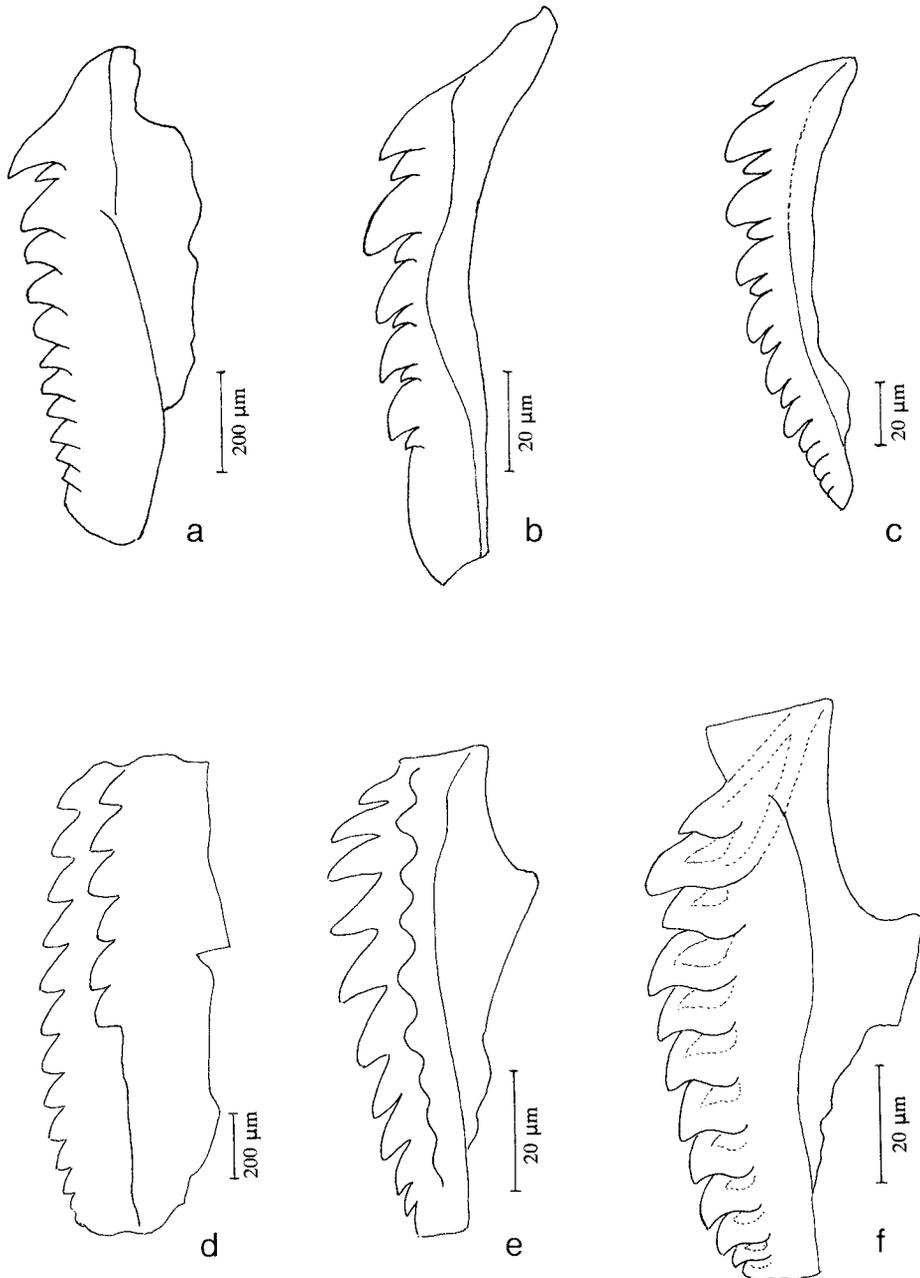


Fig. 3. Different types of jaws attributed to the genus *Staurocephalites* Hinde;  
a: *S. alterostris* Eller, 1964, pl. 5, fig. 1, with one second order denticle;  
b,c: *S. broennimanni* Jan du Chêne, 1975, pl. 1, figs. 7, 5, with first and second order denticles alternating;  
d: *S. sp.* Schwab, 1966, pl. 54, fig. 2; text-fig. 2, showing the fusion of two elements of the jaw apparatus;  
e: type JAM. 2085 resembling the combined saw-crested elements observed by Schwab, but here distinctly in one jaw;  
f: type JAM. 2014 with lateral extensions of all denticles.

inside the other. The mutual position of the denticles in both jaws (the denticles of one jaw are next to the saddles of the other, see Fig. 3d) would not be expected, according to Schwab, to be the result of a chance placement of a smaller jaw inside the fossa of the larger one during reworking. It may be assumed that the double row of denticles are the result of a fusion of the two elements of the jaw apparatus. Jan du Chêne (1975, p. 218, fig. 2, p. 220) also assumes that the double row of denticles is the result of a combination of two jaws. As the material by which the two jaws are attached to each other does not dissolve during a prolonged exposure to boiling hydrochloric acid — as was the case with type JAM. 2085 — this feature seems fundamentally different from the original concept of *Staurocephalites* and, therefore, could be considered as a distinctive characteristic at the generic level.

A third fundamentally different feature is the development of a lateral extension of each denticle as observed in *Staurocephalites* cf. *S. taugourdeausi* Jan du Chêne & Gorin (1974, pl. 6, fig. 13) and in types JAM. 2014 and 2018. A morphologically related jaw was shown by Mrs Regali in a slide during her presentation at the 5th International Palynological Congress at Cambridge (1980). This characteristic lateral extension, absent in the original *Staurocephalites* definition, could be evaluated as of generic value. In the Palaeozoic of the Scandinavian region Eisenack (1975, p. 246 - 247) found a morphological group with long ridges extending laterally in pairs from the denticles. The thin, double, chitinous lamellae of this new group, named *Lunoprionella*, are dissimilar from the single ridges observed in the Tertiary types mentioned above.

#### THE JAMAICAN TYPES OF THE *STAUROCEPHALITES* GROUPS

##### Type JAM. 2023 (Pl. 2; Fig. 7)

A ?sinistral jaw; posterior end broken off; convex side with twelve or more denticles, gradually decreasing in size from 15  $\mu\text{m}$  to 4  $\mu\text{m}$  in posterior direction; denticles slanting and curved backwards, the four anterior ones worn off; at the base of the most anterior denticle a small second order denticle is visible; the overall length of the jaw is 200  $\mu\text{m}$ .

From the upper part of the Richmond Formation near Langley, locality JHG-389. A much smaller jaw, measuring only 50  $\mu\text{m}$  was found in the lower part of the Richmond Formation at Fruitful Vale, locality JHG-107.

Morphological relationships — Closely resembling *Staurocephalites taugourdeausi* Jan du Chêne (1975, p. 221, pl. 1, figs. 5, 7) from the Palaeocene of France.

##### Type JAM. 2086 (Pl. 2; Fig. 7)

A rather worn off, ?sinistral jaw; posterior end broken off; the convex side with eight or more somewhat slanted denticles, some of which are partly worn off; the most posterior denticles are larger than the more anterior ones, reaching 10  $\mu\text{m}$  in height; about one third of the jaw-fragment is formed by the prolonged anterior part; the overall size is 120  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

**Morphological relationships** — The absence of second order denticles places it in the *Staurocephalites* s. str. group, the increase in size of the denticles in posterior direction appears different from *S. taugourdeausi* Jan du Chêne & Gorin and from type JAM. 2023.

Type JAM. 2085 (Pl. 2; Fig. 7)

A ?dextral jaw; posterior tip broken off; convex side with ten or more bluntly pointed denticles, the majority slanting in posterior direction; the most anterior denticle (5  $\mu\text{m}$ ) is smaller than the second one (9  $\mu\text{m}$ ), but the following denticles decrease gradually in size to 3  $\mu\text{m}$  at the posterior end; parallel to this row of denticles and distinctly separated from it occurs a second row of rather blunt cones, 4-3  $\mu\text{m}$  in size, situated on the outer side of the jaw; on the concave side, opposite the second denticle a little bulge is visible; the overall length of the jaw is 74  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

**Morphological relationships** — Schwab (1966) describes some specimens attributed to the genus *Staurocephalites* with two parallel rows of denticles observed in the Middle Ordovician of Tennessee, U.S.A.

Type JAM. 2014 (Pl. 2; Fig. 7)

A ?dextral jaw; posterior tip broken off; convex side with a dozen denticles slanting in posterior direction; the first and third denticle are smaller (8  $\mu\text{m}$ , second order denticles) than the second and fourth ones (10  $\mu\text{m}$ ); in other specimens three or four second order denticles have been observed, alternating with first order ones; from the fourth to the twelfth denticle the size decreases gradually to less than 2  $\mu\text{m}$ ; all denticles show a distinct lateral extension at the outer side of the jaw, each extension showing a tendency to form a new cone, as if an outer parallel row of denticles may be formed; the thickened belt on which the denticles are located shows a bulging convex part opposite the third to sixth denticle; the overall length of the jaw is 100  $\mu\text{m}$ ; other specimens measure less (75  $\mu\text{m}$ ).

From the upper part of the Richmond Formation near Langley, locality JHG-390; also found in the overlying sample JHG-391.

**Morphological relationships** — closely related to type JAM. 2018, which has only one tiny second order denticle at the anterior base of the largest first order denticle.

Type JAM. 2018 (Pl. 2; Fig. 7)

A ?sinistral jaw; posterior tip broken off; convex side with eleven or more denticles, gradually decreasing in size from 14  $\mu\text{m}$  to 4  $\mu\text{m}$ , slanting and curved in posterior direction, preceded by a 4  $\mu\text{m}$  small second order denticle;

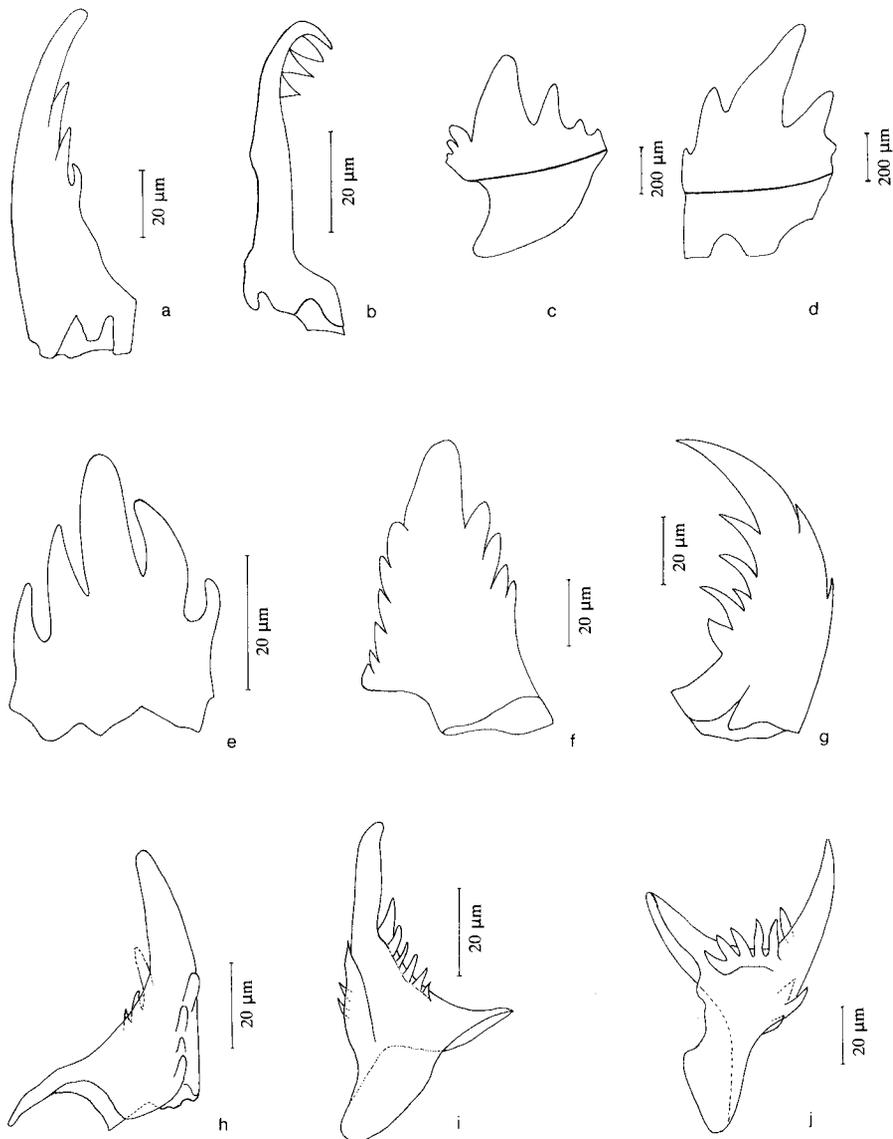


Fig. 4. Denticle arrangement in the *Nereidavus-Anisocerasites* groups;  
 a,b: *Nereidavus lombardi* Jan du Chêne & Gorin (1974, pl. 5, fig. 11) and *N. ? sp.* Jan du Chêne & Gorin (1974, pl. 5, fig. 12) both belonging to group 1 = without pre-cuspidal denticles;  
 c,d: *Anisocerasites tanaodus* Eller (1938, pl. 29, figs. 5, 6) belonging to group 2 = with pre- and post-cuspidal denticles in one plane approximately;  
 e,f: *A. weidmanni* Jan du Chêne & Gorin (1974, pl. 3, figs. 7, 9) also belonging to group 2;  
 g: *A. weidmanni* Jan du Chêne & Gorin (1974, pl. 3, fig. 3) belonging to group 3 = pre-cuspidal denticles occurring (partly) on the inner side of the jaw;  
 h: type JAM. 2077 belonging to group 4 = pre-cuspidal denticles on the inner side of the jaw, post-cuspidal denticles on the outer side;  
 i: type JAM. 2079 belonging to group 5 = pre-cuspidal denticles on the inner and on the outer side of the jaw, post-cuspidal denticles on the outer side;  
 j: type JAM. 2078 belonging to group 6 = pre- and post-cuspidal denticles on the inner and on the outer side of the jaw.

the outer side of each denticle shows a distinct lateral extension with a tendency to form a secondary cone, like the beginning of an outer row of denticles parallel to the first one; at the concave side of the jaw a faint bulge is visible opposite the third and fourth denticle; the overall length of the jaw is 144  $\mu\text{m}$ .

From the upper part of the Richmond Formation near Langley, locality JHG-385.

Morphological relationships — Closely resembling *Staurocephalites* cf. *S. taugourdeausi* Jan du Chêne & Gorin (1974, pl. 6, fig. 13). On the Fifth International Palynological Conference at Cambridge (1980) Mrs Regali showed a slide with a fragment of a morphologically related jaw from the Eocene of Brazil. Type JAM. 2014 has denticles with the same lateral extensions.

#### *Anisocerasites* Eller, 1955

So many morphologically different types have been attributed to this genus that the author understands the conclusion of Kozur (1970, p. 39) that they should be regarded as anterior jaws of various Eunicida and that the genus should be considered a nomen dubium. A detailed comparison of the Tertiary specimens from France illustrated by Jan du Chêne & Gorin (1974) and the Jamaican types with the original specimens of Eller (1938, pl. 29, figs. 5, 6) reveals that based on the three-dimensional arrangement of the denticles these jaws can be placed in six different groups (see Figs. 4, 5).

1. Jaws without pre-cuspidal denticles (*Anisocerasites weidmanni* Jan du Chêne & Gorin, 1974, pl. 2, figs. 15, 18; types JAM. 2083 and 2087; also *Nereidavus lombardi* and *N. sp.* Jan du Chêne & Gorin, 1974, pl. 5, figs. 11 and 12, respectively).

2. Jaws with pre- and post-cuspidal denticles and cusp approximately in one plane (*Anisocerasites tanaodus* Eller, 1938, pl. 29, figs. 5, 6; many specimens of *A. weidmanni* in Jan du Chêne & Gorin, 1974; types JAM. 2076 and 2082).

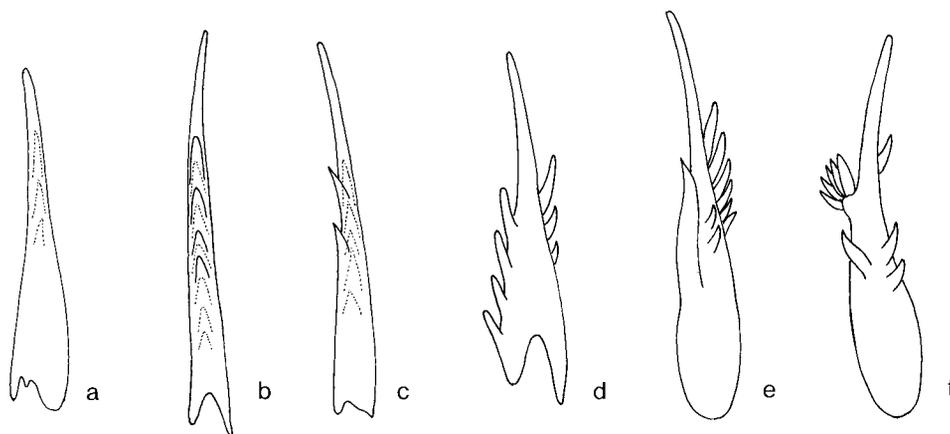


Fig. 5. Schematic drawings of the denticle arrangements in the *Nereidavus-Anisocerasites* groups in distal view; a - f = groups 1 - 6 as in Fig. 4.

3. Jaws with the post-cuspidal denticles and cusp approximately in one plane, the pre-cuspidal denticles more or less on the inner side of the jaw (many specimens of *A. weidmanni* and three of *A. fillingensis* in Jan du Chêne & Gorin, 1974; type JAM. 2092).
4. Jaws with the pre-cuspidal denticles on the inner side of the jaw and the post-cuspidal denticles on the outer side (many specimens of *A. weidmanni* and two of *A. fillingensis* in Jan du Chêne & Gorin, 1974; types JAM. 2077, 2081, 2084, 2088, and 2123).
5. Jaws with the pre-cuspidal denticles in groups on the inner and on the outer side of the jaw, and the post-cuspidal denticles on the outer side of the jaw (types JAM. 2079 and 2080).
6. Jaws with the pre- and post-cuspidal denticles in groups on the inner and on the outer side of the jaw (type JAM. 2078).

The plotting of the length/width ratios of the jaws indicated above and attributed to the genus *Anisocerasites* (Fig. 6) shows a distribution with a broad but distinct trend from short hand-shaped forms to elongated and twisted hook-shaped forms while the transition from one group to the next appears to be gradual. Close similarity between some types (e.g. three specimens of *Anisocerasites fillingensis* Jan du Chêne & Gorin, 1974 (pl. 4, figs. 13 - 15) and types JAM. 2081 and 2082) suggests that they belong to one species. However, on comparing other types in groups 2 - 6 some of the arrangements of the denticles combined with the elongation and twisting of the whole jaw appear so fundamentally different that one feels inclined to attribute some of the specimens to separate genera. Of course, the arrangement of the denticles and the length/width ratio are only two aspects of the jaws. If we look at the other features (e.g. the striate surface of the cusp and denticles of type JAM. 2123) then some of the specimens differ more from each other than should be acceptable within one species or even genus.

The most striking aspect already mentioned is the relative abundance of 'short little hands' attributed by Jan du Chêne & Gorin (1974) to *Anisocerasites weidmanni*. The scarcity of these 'little hands' in the Jamaican samples may have been the result of a sorting process during sedimentation.

#### THE JAMAICAN TYPES OF THE *ANISOCERASITES* GROUPS

##### *Group 1*

Type JAM. 2087 (Pl. 2; Fig. 7)

A ?sinistral jaw; cusp rather straight, blunt, on its concave side flanked by two blunt post-cuspidal denticles, slanting in posterior direction, 3 and 1  $\mu\text{m}$  in size; a remnant of a myocoele seems present at the posterior end of the jaw; the overall size is 28  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

Morphological relationships — Very much resembling the 'little hand' of *Anisocerasites* cf. *A. weidmanni* Jan du Chêne & Gorin (1974, pl. 2, fig. 18; pl. 6, fig. 17).

L/W	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
4.0						
3.9						
3.8	V-12					
3.7						
3.6						
3.5						
3.4						
3.3						
3.2						
3.1						
3.0					JAM.2080	
2.9			JAM.2092			
2.8	V-11					
2.7						
2.6						
2.5				JAM.2088		
2.4				V-6		
2.3			III-3, IV-16	JAM.2077		
2.2				V-3		
2.1						
2.0		II-16	IV-9	III-4	JAM.2079	JAM.2078
1.9	JAM.2083		IV-15	JAM.2084		
1.8			III-1, III-6			
1.7		V-8	III-8	IV-14		
1.6		III-9		JAM.2123		
1.5		III-5	V-5	V-10		
1.4		JAM.2076, JAM.2082				
1.3	II-15, II-18	IV-12, V-2		V-7		
1.2		II-17, V-1	III-2	IV-13,		
		A.tanaodus Fig. 6		JAM.2081		
1.1		V-9				
1.0		III-7, IV-8, IV-11	IV-1, IV-2			
0.9		IV-3, V-4				
0.8		IV-7				
0.7		II-19				
		A.tanaodus Fig. 5				
0.6		IV-6, IV-10				
0.5		IV-4				
0.4						
0.3						
0.2						
0.1						

Fig. 6. Length/width ratios in the jaws of the *Nereidavus-Anisocerasites* groups found in the illustrations of Eller, 1938, Jan du Chêne & Gorin, 1974 and the Jamaican types. T5 and T6 = *A. tanaodus* Eller, 1938, pl. 29, figs. 5, 6; II-15 to 18, IV-10 to 12, and V-1 to 9 = *A. (cf.) weidmanni* Jan du Chêne & Gorin, 1974, pls. 2-5; IV-9 and IV-13 to 16 = *A. fillingensis* Jan du Chêne & Gorin, 1974, pl. 4; V-10 = *A. sp.* Jan du Chêne & Gorin, 1974, pl. 5, fig. 10; V-11 = *Nereidavus lombardi* Jan du Chêne & Gorin, 1974, pl. 5, fig. 11; V-12 = *N. ? sp.* Jan du Chêne & Gorin, 1974, pl. 5, fig. 12; JAM. = Jamaican type numbers. The distribution of the specimens suggests a normal population, but the shape and denticle arrangements of group 2 and groups 4-6 are so diverging, that the presence of more than one species or even genus may be assumed.

#### Type JAM. 2083 (Pl. 1, Fig. 7)

A set of sinistral jaws, placed in parallel position by coincidence?; cusps blunt, almost straight, flanked at the concave side by eight, sharply pointed, straight denticles in slanted position, the anterior ones about 2  $\mu\text{m}$  long, the others

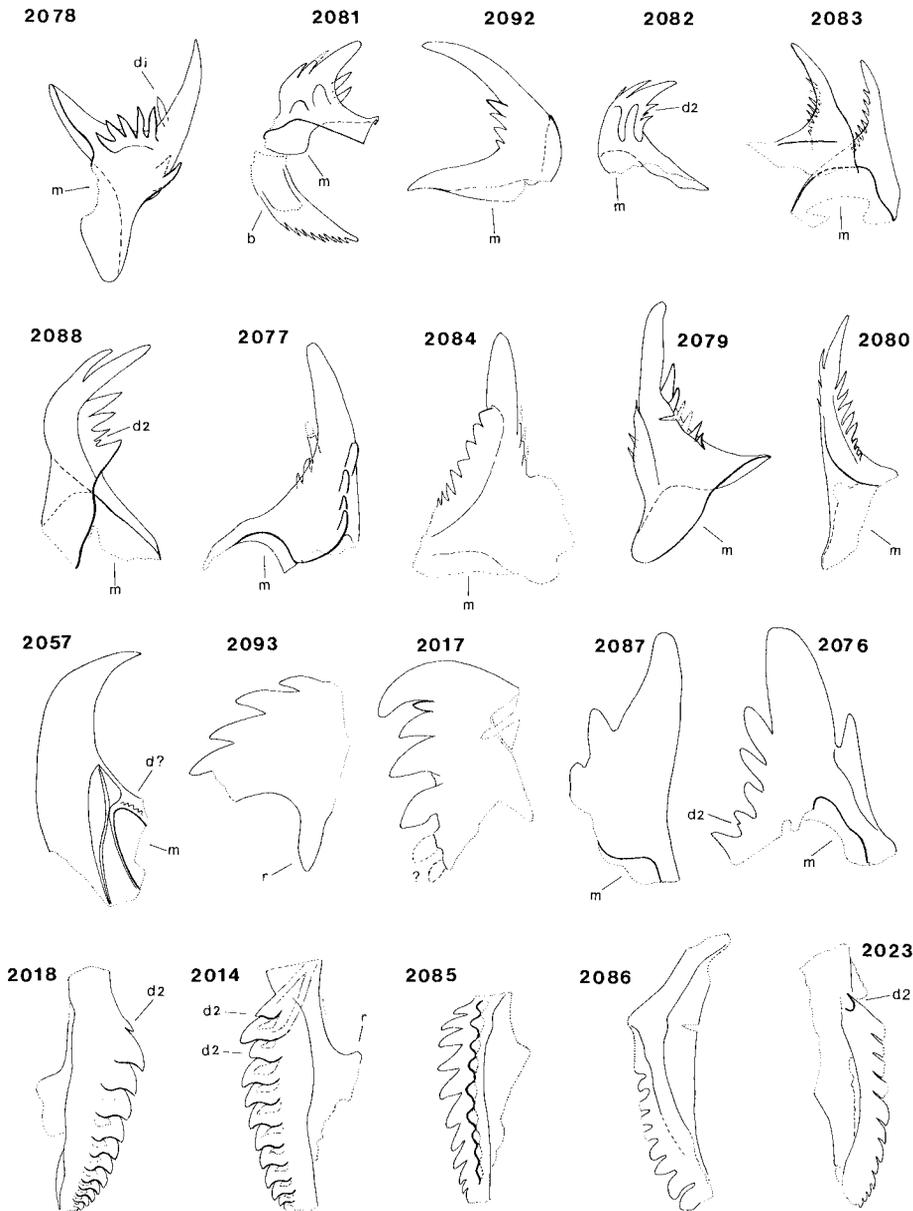


Fig. 7. Denticle arrangement in the JAM. types illustrated on Plates 1 and 2; d2 = second order denticle, di = post-cuspidal denticles on the inner side of the jaw, m = myocoele, r = ramus, b = basal plate?

gradually decreasing in size to  $1 \mu\text{m}$  and located progressively more to the outer side of the jaws; the myocoeles are very wide, leaving no doubt about the originally sinistral position in the jaw apparatus; the overall size of the jaws is  $32 \mu\text{m}$  and  $30 \mu\text{m}$ , respectively.

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

### Group 2

Type JAM. 2076 (Pl. 1, Fig. 7)

A sinistral jaw, with a straight, blunt cusp, flanked by a row of post-cuspidal denticles, all slanting in the anterior direction, varying in size from 11 to 7  $\mu\text{m}$ ; with a 1  $\mu\text{m}$  small second order denticle (or secondary denticle) attached to the fourth one; anterior to the cusp one 10  $\mu\text{m}$  long, straight, pre-cuspidal denticle, pointing almost in the same direction as the cusp; at the posterior end the remnants of a myocoele with an irregular inner margin are visible; the overall length of the jaw is 75  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4; a second specimen measures 52  $\mu\text{m}$  only.

Morphological relationships — Closely related to some specimens of *Anisocerasites weidmanni* Jan du Chêne & Gorin, 1974 (see Fig. 6, group 2). Like type JAM. 2087 this is one of those 'little hands' discussed in the paragraph on *Anisocerasites* Eller, 1955.

Type JAM. 2082 (pl. 1; Fig. 7)

A sinistral jaw; the anterior end has a slightly curved, sharply pointed cusp, closely flanked at the concave side by three sharply pointed post-cuspidal denticles in forward slanting position, two of which are 3  $\mu\text{m}$  long, a second order denticle between the two is just over 1  $\mu\text{m}$  long; at the convex side of the cusp two sharply pointed pre-cuspidal denticles in forward slanting position are 6 and 3  $\mu\text{m}$  long; parallel to the belt on which the post-cuspidal denticles rest occurs a second, more central belt, ending at a short distance from the wide myocoele; the overall length is 28  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

Morphological relationships — Closely related to some specimens of *Anisocerasites fillingensis* Jan du Chêne & Gorin (1974, pl. 4, figs. 13 - 15; pl. 6, figs. 7, 8) and also to type Jam. 2081.

### Group 3

Type JAM. 2092 (Pl. 1; Fig. 7)

A dextral jaw; the anterior end is formed by a long, slightly curved cusp with a blunt tip, flanked by sharply pointed post-cuspidal denticles in slanting position, varying in size from 6  $\mu\text{m}$  (anterior) to 2  $\mu\text{m}$  (posterior); at the convex side a thick, 16  $\mu\text{m}$  long pre-cuspidal denticle with a tapering and sharply pointed end lies close to the basal part of the cusp, and is situated slightly on the inner side of the jaw; a distinct myocoele is present; the overall length of the jaw is 57  $\mu\text{m}$ .

From the upper part of the Richmond Formation, near Langley, locality JHG-374.

#### Group 4

##### Type JAM. 2088 (Pl. 1; Fig. 7)

A sinistral jaw; a long straight cusp at the anterior end is flanked at the concave side by five sharply pointed post-cuspidal denticles varying in size from 7 to 3  $\mu\text{m}$ , with a second order denticle of 1  $\mu\text{m}$  as the fourth; these denticles are located on a distinct belt at the outer side of the jaw; one rather blunt, 9  $\mu\text{m}$  long pre-cuspidal denticle points in almost the same direction as the cusps; a wide myocoele is present; the overall length of the jaw is 50  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4; a second specimen measures 48  $\mu\text{m}$ .

Morphological relationships — Closely related to *Anisocerasites fillingsensis* Jan du Chêne & Gorin, 1974 (paratype pl. 4, fig. 9). Morphologically related jaws from the Eocene and Oligocene of Brazil were shown in several slides by Mrs Regali during the 5th International Palynological Congress at Cambridge (1980).

##### Type JAM. 2077 (Pl. 2, Fig. 7)

A sinistral jaw; at the anterior end a long, blunt cusp, flanked at the concave side by three post-cuspidal denticles situated slightly on the outer side of the jaw; the largest denticle, without the tip, is 10  $\mu\text{m}$  long, the other two are smaller, slanting in forward direction and slightly curved; at the convex side of the cusp four pre-cuspidal denticles are situated on the inner side of the jaw, the largest one is 11  $\mu\text{m}$  long, and probably misses its tip too; a part of the myocoele is still preserved; the overall length of the jaw is 73  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

Morphological relationship — A paratype of *Anisocerasites weidmanni* Jan du Chêne & Gorin (1974, pl. 3, fig. 3) appears more close than others.

##### Type JAM. 2084 (Pl. 2; Fig. 7)

A dextral jaw; end of the myocoele broken off; concave side with eight or more rather sharp post-cuspidal denticles of which the four anterior ones are slanting in forward direction, decreasing in size from 8  $\mu\text{m}$  to 3  $\mu\text{m}$ ; three pre-cuspidal denticles, somewhat on the inner side of the jaw, have been broken off; a thickened belt supports the post-cuspidal denticles situated slightly on the outer side; a remnant of the myocoele indicates the dextral character of the jaw; the overall length of the jaw is 74  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

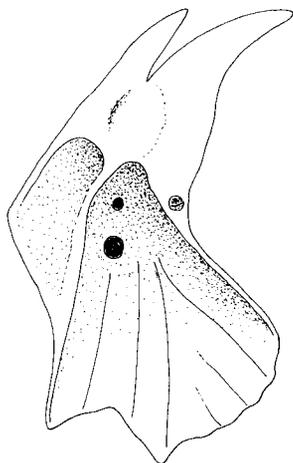


Fig. 8. Type JAM. 2123, drawing as seen from the side of the myocoele, size 1230  $\mu\text{m}$  (see also Fig. 9).

#### Type JAM. 2123 (Figs. 8, 9)

A sinistral jaw; very asymmetrical with about twenty post-cuspidal denticles on the outer side of the jaw, raising from a broad, massive belt; one pre-cuspidal denticle, slightly smaller than the cusp, occurs slightly on the inner side; the denticles vary in height from approximately 440  $\mu\text{m}$  to 50  $\mu\text{m}$ ; the cusp and all denticles are distinctly striate, except at the tip which has a sharply delimited smooth apical end (40  $\mu\text{m}$ ); the striae, approximately 4  $\mu\text{m}$  wide, consist of two rows of ridges separated by a narrow groove; striae 8  $\mu\text{m}$  apart from each other; a large myocoele, only partly enclosed, on the inner side shows distinct interior ridges (Fig. 8); the overall length of the jaw is 1230  $\mu\text{m}$ .

From the lower part of the Richmond Formation at the Oracabessa River, locality JHG-413.

#### Type JAM. 2081 (Pl. 1; Fig. 7)

A dextral jaw and a basal plate attached to each other; at its anterior end the jaw has a blunt cusp, flanked at the concave side by two sharply pointed post-cuspidal denticles, 5  $\mu\text{m}$  and 6  $\mu\text{m}$  respectively; these denticles are placed at the outer side of the jaw; two pre-cuspidal denticles, of which one is broken off, are 5  $\mu\text{m}$  long; parallel to the post-cuspidal belt occurs a central belt and a third thickening stretches from the cusp towards the posterior end; a wide myocoele is present. The attached fragment is considered to be a basal plate; it is flat, elongated and slightly curved with at the distal end a small blunt cusp, about 2  $\mu\text{m}$  long and 1  $\mu\text{m}$  thick, flanked by a series of about nine slightly smaller, sharply pointed, closely placed, post-cuspidal denticles; its thinner central part may be considered homologous with an open myocoele; the overall diameter of the whole structure is 40  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantmore River, west of Bloomfield, locality Krijnen K74-4.

Morphological relationships — Closely related to some specimens of *Anisoce-rasites fillingensis* Jan du Chêne & Gorin (1974, pl. 4, figs. 13 - 15; pl. 6, figs. 7, 8) and also to type JAM. 2082.

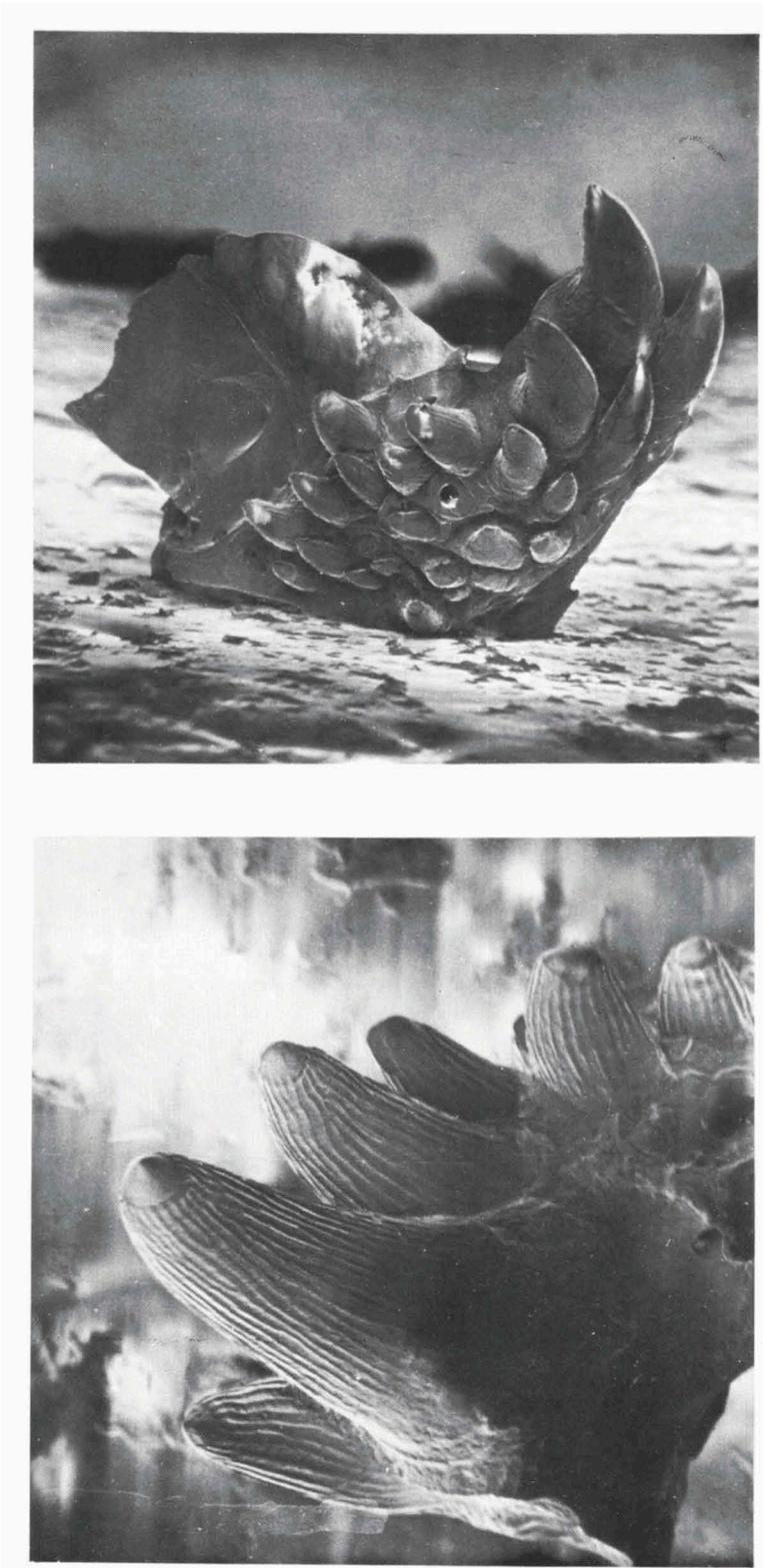


Fig. 9. Type JAM. 2123, sinistral jaw, 1230  $\mu\text{m}$ , from locality JHG-413 (see also Fig. 8).

### Group 5

Type JAM. 2080 (Pl. 1; Fig. 7)

A sinistral jaw; the anterior end has a long, rather blunt cusp; at its concave side, slightly at the outer side of the jaw, occur eight sharply pointed denticles, the anterior five cones are about 4-5  $\mu\text{m}$  long, the next three ones about 2  $\mu\text{m}$ , all are attached to a thick belt; at the convex side of the cusp three sharply pointed pre-cuspidal denticles occur on the inner side of the jaw, the anterior denticle 5  $\mu\text{m}$  long, the other two about 2-3  $\mu\text{m}$  long; the largest diameter of the jaw is 68  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

Morphological relationships — Resembling a paratype of *Anisocerasites weidmanni* Jan du Chêne & Gorin (1974, pl. 3, fig. 3) but his specimen is less elongated.

Type JAM. 2079 (Pl. 1; Fig. 7)

A sinistral jaw; the large cusp is straight and blunt; at its concave side it is flanked by a row of post-cuspidal denticles varying in size from 10  $\mu\text{m}$  to 4  $\mu\text{m}$ , two of which are broken off (one fallen sideways), all situated slightly on the outer side of the jaw; on the convex side of the cusp a 23  $\mu\text{m}$  long pre-cuspidal denticle with a tapering and sharply pointed end lies close to the basal part of the cusp; this large denticle bears two small, sharply pointed denticles slightly to the inner side of the jaw; each denticle is about 4  $\mu\text{m}$  large; a distinct myocoele is wide open; the overall length of the jaw is 74  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

### Group 6

Type JAM. 2078 (Pl. 1; Fig. 7)

A dextral jaw; cusp long, slightly curved and sharply pointed; at its concave side are five post-cuspidal denticles situated on a distinct belt on the outer side of the jaw; these denticles are sharply pointed and vary in size from 14  $\mu\text{m}$  to 9  $\mu\text{m}$ ; more closely to the cusp occurs one sharply pointed, 13  $\mu\text{m}$  long post-cuspidal denticle attached to the inner side of the jaw; three pre-cuspidal denticles are observed: a 10  $\mu\text{m}$  long, curved one on the outer side, two slightly curved, 8  $\mu\text{m}$  long ones on the inner side; a distinct myocoele is wide open; the overall length of the jaw is 100  $\mu\text{m}$ .

From a young fissure filling in the Chepstow Limestone Formation at Bantimore River, west of Bloomfield, locality Krijnen K74-4.

*Leogenys* Jansonius & Craig, 1971

According to Kozur (in Taugourdeau, 1978) this is a synonym of *Kettnerites*

Žebera, 1935. Type JAM. 2093, although incomplete, shows enough details (ramus and post-cuspidal denticles, shape) to conclude that this specimen belongs to *Leogenys*. It differs from *L. sabaudiensis* Jan du Chêne (1975, pl. 1, fig. 1) in the reduced size of the most anterior denticle. In this respect it resembles the specimen of type JAM. 2017 which is complete at its anterior end but lacks a great part of the posterior end, among which the ramus.

Type JAM. 2093 (Pl. 2; Fig. 7)

Jaw with the anterior end with cusp missing, probably broken off, as suggested by the closely resembling fragment type JAM. 2017; four curved post-cuspidal denticles are preserved, slanting in a posterior direction; the central denticle is the largest (20  $\mu\text{m}$ ) the others are smaller, the most anterior one is only 15  $\mu\text{m}$ ; a distinct ramus and bight occur opposite the denticles; the overall length of the fragment is 120  $\mu\text{m}$ .

From the upper part of the Richmond Formation, locality JHG-384.

Morphological relationship — It resembles type JAM. 2017.

Type JAM. 2017 (Pl. 2; Fig. 7)

The cusp at the anterior end is strongly curved and points in posterior direction, just like the denticles of which four have been preserved; the base of two more denticles is recognizable; the posterior denticle is 15  $\mu\text{m}$  long, the smallest denticle near the cusp is only 7  $\mu\text{m}$  and points sideways; a possible ramus and bight have been broken off; the overall length of the fragment is 92  $\mu\text{m}$ .

From the lower part of the Richmond Formation at Dry River, locality JHG-333.

Morphological relationship — It resembles type JAM. 2093.

## Plate 1

Details about the sample localities are given on p. 2,3.

Type JAM. 2092, dextral jaw, 57  $\mu\text{m}$ , from locality JHG-374.

Type JAM. 2088, sinistral jaw of *Anisocerasites fillingsensis* Jan du Chêne & Gorin, 50  $\mu\text{m}$ , from locality K74-4.

Type JAM. 2082, sinistral jaw, 28  $\mu\text{m}$ , from locality K74-4.

Type JAM. 2083, two sinistral jaws found together, 32  $\mu\text{m}$  and 30  $\mu\text{m}$ , from locality K74-4.

Type JAM. 2080, sinistral jaw, 68  $\mu\text{m}$ , from locality K74-4.

Type JAM. 2079, sinistral jaw, 74  $\mu\text{m}$ , from locality K74-4.

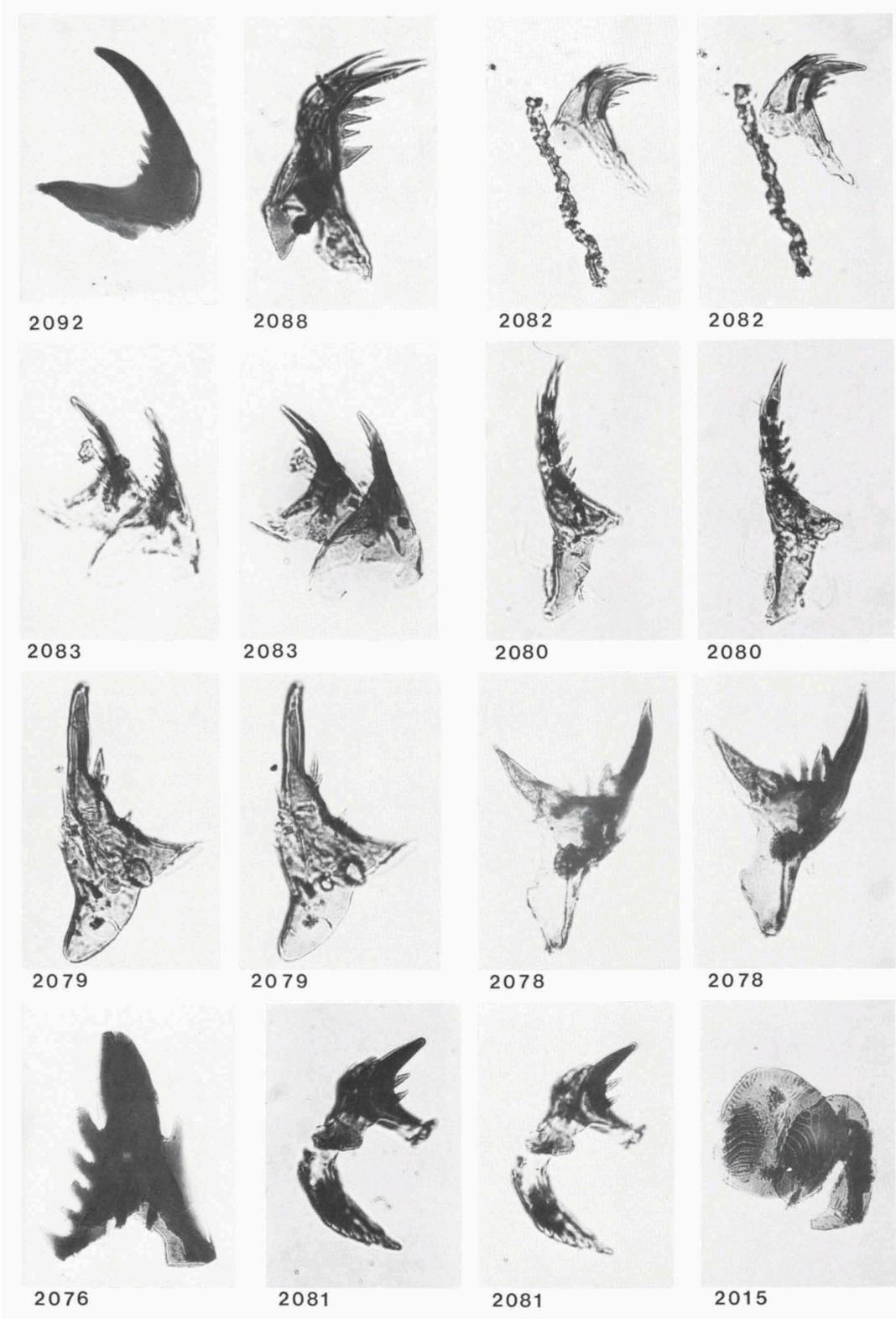
Type JAM. 2078, dextral jaw of *Anisocerasites weidmanni* Jan du Chêne & Gorin, 100  $\mu\text{m}$ , from locality K74-4.

Type JAM. 2076, sinistral jaw, 75  $\mu\text{m}$ , from locality K74-4.

Type JAM. 2081, dextral jaw, 40  $\mu\text{m}$ , from locality K74-4

Type JAM. 2015, grinding plates, 80  $\mu\text{m}$ , in diameter, from locality JHG-390.

Plate 1



## A FALX OF SCOLECODONT CHARACTER

Type JAM. 2057 (Pl. 2; Fig. 7)

This falx is 60  $\mu\text{m}$  long, sharply pointed and strongly curved; on the posterior side an enclosed myocoele has a thickened, finely dentate rim at the concave side; the enclosed side of the myocoele is reinforced by longitudinal thickenings.

From Holocene strata at Bowden, locality JHG-592.

Morphological relationships — There is a faint resemblance with *Symmetroprion* and *Atraktoprion*, and with the cephalopod arm hooks described by Kulicki & Szaniawski (1972).

## INCERTAE SEDIS

One specimen is described which can not yet be attributed to any zoological group. This type JAM. 2015 appears to be a pair of grinding plates and it has been found in the marine deposits of the Middle Eocene part of the Richmond Formation.

Type JAM. 2015 (Pl. 1)

Perhaps a pair of grinding plates, each with two oval fields with partly parallel ridges of different pattern (!); fields  $40 \times 25 \mu\text{m}$ , with eight or nine ridges, each about  $5 \mu\text{m}$  wide; plates almost circular with an  $8 \mu\text{m}$  wide margin with radially placed, 1-2  $\mu\text{m}$  wide ridges and grooves; plates  $80 \mu\text{m}$  in diameter.

From the upper part of the Richmond Formation near Langley, locality JHG-390.

## Plate 2

Details about the sample localities are given on p. 2,3.

Type JAM. 2014, left: type specimen, ?dextral jaw of *Staurocephalites* s.l.  $75 \mu\text{m}$ , from locality JHG-390; middle: two other specimens,  $92 \mu\text{m}$  and  $100 \mu\text{m}$  respectively, from locality JHG-390; right: one specimen,  $80 \mu\text{m}$ , from locality JHG-391.

Type JAM. 2018, ?sinistral jaw,  $144 \mu\text{m}$ , from locality JHG-385.

Type JAM. 2086, ?sinistral jaw of *Staurocephalites* cf. *S. taugourdeausi* Jan du Chêne & Gorin,  $120 \mu\text{m}$ , from locality K74-4.

Type JAM. 2023, left: type specimen, ?sinistral jaw of *Staurocephalites* cf. *S. taugourdeausi* Jan du Chêne & Gorin,  $200 \mu\text{m}$ , from locality JHG-389; right: other specimen,  $50 \mu\text{m}$ , from locality JHG-107.

Type JAM. 2057, dextral falx,  $60 \mu\text{m}$ , from locality JHG-592.

Type JAM. 2087, ?sinistral jaw of *Anisocerasites* cf. *A. weidmanni* Jan du Chêne & Gorin,  $28 \mu\text{m}$ , from locality K74-4.

Type JAM. 2017, jaw of ?*Leogenys* sp.,  $92 \mu\text{m}$ , from locality JHG-333.

Type JAM. 2093, jaw of ?*Leogenys* sp.,  $120 \mu\text{m}$ , from locality JHG-384.

Type JAM. 2085, ?dextral jaw of *Staurocephalites* s.l.,  $74 \mu\text{m}$ , from locality K74-4.

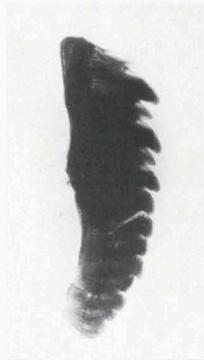
Type JAM. 2084, dextral jaw,  $74 \mu\text{m}$ , from locality K74-4.

Type JAM. 2077, sinistral jaw,  $73 \mu\text{m}$ , from locality K74-4.

Plate 2



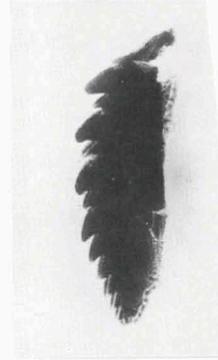
2014



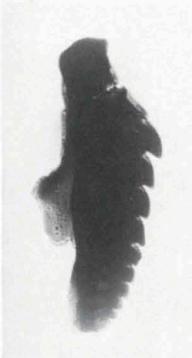
2014



2014



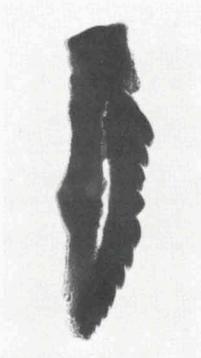
2014



2018



2086



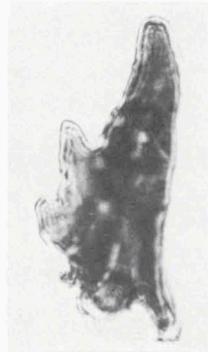
2023



2023



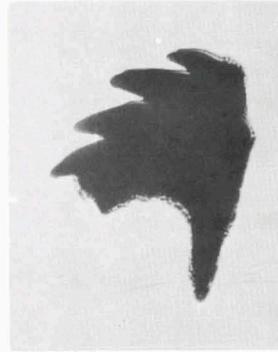
2057



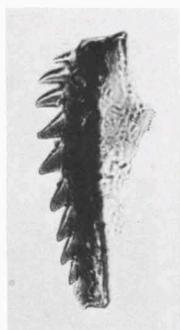
2087



2017



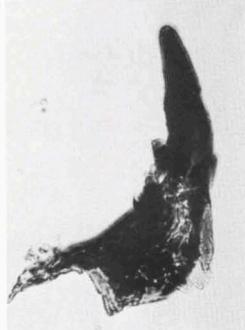
2093



2085



2084



2077



2077

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