A C T A P A L A E O N T O L O G I C A P O L O N I C A
Vol. 23 1978 No. 3

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CONODONTS OF THE GENUS *MISIKELLA* KOZUR AND MOCK, 1974 FROM THE RHAETIAN OF THE TATRA MTS (WEST CARPATHIANS)

Abstract. — Rhaetian conodonts are reported for the first time from the Tatra Mts. Two conodont species: *Misikella posthernsteini* Kozur and Mock, 1974, and *Misikella* sp. A, found in the sub-tatric (Choč) Rhaetic cropping out at the foot of Siwiańskie Turnie, are described and figured. The stratigraphic position and value of these conodonts is discussed on the background of foraminifer zonal scheme.

INTRODUCTION

The youngest Triassic conodonts, belonging to the genus *Misikella* Kozur and Mock, 1974, were found in Rhaetic rocks of the Choč nappe which crop out on western slope of the Chochołowska Valley at the foot of Siwiańskie Turnie in western part of the Tatra Mts (pl. 37: 1). This is the first locality of Rhaetian conodonts in the Tatra Mts and one of a few in the world only.

The dissolving of about 30 kg of Rhaetic limestones in acetic acid give 35 conodont specimens. The conodont-bearing samples were derived from layers 3—5 in the studied profile (pl. 37: 2). The number of specimens present in 1 kg productive samples ranged from 1 to 3. The conodont material is housed in the Institute of Paleobiology of the Polish Academy of Sciences in Warsaw (abbreviated as ZPAL).

SEM micrographs were made in the Laboratory of the Electron Microscopy of the Nencki Institute of Experimental Biology of the Polish Academy of Sciences in Warsaw.

This work is a contribution to the IGCP Project: "*Triassic of the Tethys Realm.*"

Acknowledgements. — The author is indebted to Professor H. Mostler (Institute of Geology and Paleontology of the Innsbruck University), Dr. R. Mock (Department of Geology and Paleontology of the Comenius University, Bratislava), Dr. J. Trammer and Dr. K. Zawidzka (both of the Institute of Geology of the Warsaw University) for kind discussions.

Thanks are also due to Dr. S. K. Skwarko and R. S. Nicoll (Bureau of Mineral Resources, Canberra) for the loan of thin sections of rocks of the Kuta Formation (Papua, New Guinea) for comparative studies. It is also a pleasure to thank Mrs J. Skarżyńska (Institute of Paleobiology of the Polish Academy of Sciences, Warsaw) for technical assistance.

The author is deeply indebted to Professor Walter C. Sweet (Department of Geology and Mineralogy of the Ohio State University, Columbus) for constructive review of the manuscript.

GEOLOGICAL SETTING

The conodonts were found in Rhaetic deposits of the Choč nappe, forming a small crag at the foot of Siwiańskie Turnie (pl. 37: 1, 2). The studied Rhaetic sequence, about 6 m thick, comprises grey and light-grey limestones and represents a normal succession of layers. The strike and dip are equal 80°/32° N. Three lithological complexes may be differentiated here: 1° laminated micrites (layers *1*, *2*) with single remains of bivalves, gastropods and ostracodes as well as some foraminifers *Glomospira* sp.; 2° conodont-bearing somewhat sandy biopelsparites (layers *3*—*5*), about 160 cm thick and containing small fragments of crinoids as well as foraminifers typical of the Lower Rheatian (*sensu* Gaździcki 1974*a*): *Glomospira* sp., *Glomospirella* cf. *friedli*, *G. parallela*, *Trochammina* sp., *Agathammina* sp., and *Nodosaria* sp. There are also present algae *Aciculella* sp.; 3° crinoid-brachiopod biosparites (layers *6*—*10*) with corals, ooids and intraclasts (compare pl. 37: 2 and Gaździcki and Zawidzka 1973). Foraminifers of the family Involutinidae Bütschli, and especially the representatives of *Triasina hantkeni* Majzon (pl. 37: 2; see also Gaździcki and Zawidzka 1973: pl. 3: 1—4) are most common here.

CHARACTERISTICS OF CONODONT FAUNA

Conodonts freed from the rock (35 specimens) represent spathognathodid elements only. The bulk of them (29 specimens) belong to the species *Misikella posthernsteini* Kozur and Mock, 1974. The remaining ones (pl. 40: 1, 2), with features transitional between *Misikella hernsteini* (Mostler) and *Misikella posthernsteini* Kozur and Mock, are here described as *Misikella* sp. *A*.

Plate 37: 2 and table 1 show stratigraphic distribution and number of representatives of these species in the samples. The studied material is well-preserved and some of the specimens are complete (see pl. 39: 4*a*, *c*).

Ornamentation. Some specimens display microornamentation. Longitudinal striation is common (pl. 38: 2*a*; pl. 39: 2, 3, 4*a*, *b*; pl. 40: 2). It is

Table 1

Distribution and number of conodonts in Rhaetic limestones of the Siwiańskie Turnie (see pl. 37: 2)

Sample	2	3	4	5	6
Misikella posthernsteini	—	16	10	3	—
Misikella sp. A	—	5	1	—	—

especially well-developed on denticles, weakening or completely disappearing on sides in place where the denticles are fused in the form of a solid plate (pl. 39: 2). Parallel lamellar structure was found within basal cavity of some studied specimens (pl. 40: 1*b*). Attention should be also paid to the presence of cellate ornamentation (pl. 38: 2*a*, *b*; pl. 39: 4*a*; pl. 40: 2*a*). The cells are polygonal in outline and variable in size, They are developed on both the surface of denticles (pl. 38: 2*a*; pl. 40: 2*a*) and the sides of the specimens (pl. 39: 4*a*; pl. 40: 2*a*). On some specimens, ornamentation of this type occurs together with longitudinal striation (pl. 38: 2*a*; pl. 39: 4*a*; pl. 40: 2*a*). The above types of microornamentation were previously found on Early Anisian platformed conodonts (see Nicora 1977) whereas the cellate ornamentation may be noted on one of specimens of *Misikella posthernsteini* figured from the Kuta Formation of Papua, New Guinea, by Skwarko *et al.* (1976: fig. 4*B*).

Evolutionary trends. The species *Misikella posthernsteini* Kozur and Mock, 1974 might have evolved from *Misikella hernsteini* (Mostler, 1967). The evolution may have been connected with reduction in number of denticles and the infolding of the posterior margin (see Kozur and Mock 1974 *a*, *b*; Skwarko *et al.* 1976; Mostler *et al.* 1978; Gaździcki *et al.* 1978). It is highly probable that *Misikella* sp. A represents a member of the evolutionary line *Misikella hernsteini* — *Misikella* sp. *A* — *Misikella posthernsteini.*

The record of the assemblage of conodonts *Misikella posthernsteini* and *Misikella* sp. *A*, at present found in the Tatra Mts makes it possible to draw some general conclusions. First of all, it gives further support to their stratigraphic value as well as wide geographic distribution within the Tethys Realm (see Kozur and Mock 1974*a*, *b*; Skwarko *et al.* 1976, Mostler *et al.* 1978, Gaździcki *et al.* 1978). At the same time, the lack of any other elements of conodonts apparatus in the samples analysed except for the spathognathodid suggests that it was the last element remaining in the apparatus of the conodontophorid animal. The scarcity and marked monotype of conodonts in the Rhaetian may also reflect evolutionary changes in this group taking place just before its extinction at the end of the Triassic.

It should be noted that the forms of the genus *Misikella* Kozur and Mock, such as *Misikella hernsteini, Misikella* sp. *A*, and *Misikella posthernsteini* appear somewhat similar to *Spathognathodus divergens* Bender and Stoppel from the Middle Permian (Bender and Stoppel 1966; see also Szaniawski 1969). Up to the present, no connecting link between *Spathognathodus divergens* and above discussed misikellas were found in uppermost Permian — lower Upper Triassic. Therefore it seems that the similarity is best explained by homeomorphy (see also Mosher 1968).

STRATIGRAPHICAL REMARKS

The detailed micropaleontological studies recently carried out on classic sections of the Upper Triassic of the Carpathians and Alps (see Gaździcki *et al.* 1978 Mostler *et al.* 1978) show that *Misikella posthernsteini* first appears in the uppermost Sevatian, where it occurs together with *Misikella hernsteini*. The species *Misikella hernsteini* disappears at the Norian / Rhaetian boundary, whereas *Misikella posthernsteini* occurs up to the upper boundary of the *Choristocers marshi* Zone in the Upper Rhaetian ammonite zonation (table 2; see also Kozur and Mock 1974*b*; Mostler *et al.* 1978; Gaździcki *et al.* 1978). This made it posible to different-

Table 2

Stratigraphic correlation of the ammonoid, conodont and foraminifer zones in the Rhaetian of the Alpine-Mediterranean region. For stratigraphic comments see Gaździcki *et al.* 1978

STAGE	RHAETIAN	
SUBSTAGES	LOWER	UPPER
Ammonoid zones	*haueri*	*marshi*
Conodont zones	*posthernsteini*	
Foraminifer zones	*pokornyi friedli*	*hantkeni*

iate a *Misikella posthernsteini* conodont Zone in the Rhaetian of the Alpine-Mediterranean region (Kozur and Mock 1974*b*; see also Gaździcki *et al.* 1978). The lower boundary of this zone would be defined by the disappearance of *Misikella hernsteini* and the upper — by disappearance of *Misikella posthernsteini* (see Kozur and Mock 1974*b*).

The limestones cropping out at the foot of Siwiańskie Turnie (pl. 37: 1, 2) were previously dated at the Rhaetian (Guzik and Guzik 1958; Guzik

1959). The record of foraminifers typical of the *Triasina hantkeni* Zone made it possible to more precisely date the rocks as Upper Rhaetian (Zawidzka 1972; Gaździcki and Zawidzka 1973). Further analysis of foraminifers from the studied section (pl. 37: 2) as well as of the material gathered by A. Wygralak, M. Sc., in the Siwiańskie Turnie area (Wygralak 1974), showed that the Lower Rhaetian (*Glomospirella pokornyi* and *Glomospirella friedli* Zone) is also present here. The presence of *Misikella posthernsteini* and the complete lack of the representatives of *Misikella hernsteini* gives further support to the Rhaetian age of limestones cropping out at the foot of Siwiańskie Turnie. The dating based on conodonts would be the second (after the foraminifer dating) evidence for the Rhaetian in the Tatra Mts based on guide fauna (table 2, see also Gaździcki 1978).

Attention should also be paid to the very short stratigraphic range of the newly described form *Misikella* sp. *A* (table 1), which implies that it may be stratigraphically important.

It should be stated that the conodonts discussed here were derived from lower part (layers *3*—*5*) of the Rhaetic section cropping out at the foot of Siwiańskie Turnie (pl. 37: 2), dated at the Lower Rhaetian (*pokornyi* and *friedli* Zone) on the basis of foraminifers and overlain by Upper Rhaetian (*hantkeni* Zone) with a good paleontological record.[1)]

It follows that the conodonts *Misikella posthernsteini* and *Misikella* sp. *A* occur in the Choč Rhaetic of the western part of the Tatra Mts in identical stratigraphic position as a single specimen identified as *Misikella posthernsteini* hitherto found in classic locality of the Kössen Beds at Hybe (Slovakia) (see Michalik 1973; Kozur and Mock 1974*b*). At Hybe, the Upper Rhaetian (*hantkeni* Zone)[2)] is unknown and only the Lower Rhaetian (*pokornyi* and *friedli* Zone) is well evidenced (Gaździcki and Zawidzka 1973; Gaździcki 1974*a*, *b*).

It should be also noted that the Kuta limestone from Papua New Guinea, from which two specimens of *Misikella posthernsteini* were recently reported by Skwarko *et al.* (1976) may be dated at the Lower Rhaetian (*pokornyi* and *friedli* Zone) on the basis of foraminifers.[3)]

[1)] The zonation based on conodonts and foraminifers (table 2) was correlated with the stratigraphic subdivision of the Rhaetian sensu Kozur (1973), concordant with the priority Gümbel's (1861) subdivision (see also Gaździcki *et al.* 1978).

[2)] Bystrický (1975: 190) reported the presence of *Triasina hantkeni* in basal layers of the Kössen Beds from Hybe section, at the same time questioning stratigraphic value of foraminifers for zonation of the uppermost Triassic. The analysis of Bystricky's thin sections from basal layers of the Kössen Beds (coll. GU SAV), made by the present author, showed that the forms interpreted as representatives of *Triasina hantkeni* (cf. Bystrický 1975) are, in fact, ooids subjected to neomorphic replacement and dissolution processes in their diagenesis. The comments made by Bystrický (1975) are, therefore, unjustified.

[3)] Thanks to the courtesy of Dr. S. K. Skwarko and Dr. R. S. Nicoll, Canberra, the author had an opportunity to analyse thin sections of the Kuta Formation. The analysis showed the presence of *Glomospirella friedli* Kristan-Tollmann, 1962, and other time-sensitive forms.

DESCRIPTIONS

Genus *Misikella* Kozur and Mock, 1974

Type species: *Spathognathodus hernsteini* Mostler, 1967

Misikella posthernsteini Kozur and Mock, 1974

(pl. 38: 1*a*, *b*—3*a*, *b*; pl. 39: 1—4*a*-*c*; pl. 40: 3)

1968. *Neospathodus lanceolatus* Mosher (part): 930, pl. 115: 7 only.
1974. *Misikella posthernsteini* Kozur and Mock: 247, figs 1—4.
1976. *Misikella posthernsteini* Kozur and Mock; Nicoll *in*: Skwarko *et al.*: 222, fig. 4 *A*—*H*.

Material. — Twenty-nine specimens.

Remarks. — The studied forms are spathognathodid elements with a strong laterally expanded deep cavity and the number of denticles usually reduced to three (pl. 38: 2*a*, *b*; pl. 39: 4*a*, *b*). Denticles fused at the base and posteriorly inclined (pl. 38: 2a, b). All the specimens are high (about 0.3 mm high; see pl. 38: 1*a*, *b*; pl. 39: 1, 2) and usually much higher than long (about 0.2 mm long). Attention should be paid to the posterior margin of the element which is markedly folded into the basal cavity (pl. 39: 4*b*, *c*), resulting in origin of a groove, fairly deep and wide at the base and stretches along large posterior denticle from basal cavity (pl. 38: 3*a*, *b*; pl. 39: 4*b*, *c*). The specimens from the collection studied, assigned to this species (those figured in pl. 38: 1*a*, *b*, 3*a*, *b*; pl. 39: 1—4*a*-*c*; pl. 40: 3, and others), have all the features characteristic of *Misikella posthernsteini* Kozur and Mock (see figures and descriptions given by the authors listed in the synonymy).

Occurrence. — In the Rhaetian (*haueri*-and *marshi* Zones) of the Steinbergkogel, Kendelbachgraben and Weissloferbach sections in Austria (Mosher 1968; Kozur and Mock 1974*b*; Mostler *et al.* 1978; Gaździcki *et al.* 1978) Hybe and Malý Mlynský vrch sections in Slovakia (Kozur and Mock 1974*b*; Gaździcki *et al.* 1978), Kuta Formation in Papua New Guinea (Skwarko *et al.* 1976), and recently in the Tatra Mts (Poland) (this paper).

Misikella sp. *A*

(pl. 40: 1*a*, *b*—2*a*-*c*)

Material. — Six specimens.

Description. — A spathognathodid element quadrate in side view (pl. 40: 1*a*, 2*a*) and almost equally high (about 0.2 mm) as long. All the specimens available are characterized by five denticles fused at the base but are well differentiated and acutely pointed toward the apex. The denticles are laterally compressed (pl. 40: 1*b*, 2*b*) and posteriorly inclined. Anterior denticle is here an exception as it is set perpendicular to the base (pl. 40: 1*a*, 2*a*) and triangular in outline. Basal cavity, laterally expanded and deeply excavated (pl. 40: 1*b*, 2*b*); occupies the entire basal area of element and markedly V-shaped. Posterior margin somewhat folded into it (pl. 40: 1*b*, 2*b*, *c*), which is accompanied by formation of groove wide at the base and reaches the point of inflexion of posterior denticle (pl. 40: 2*c*). Anterior margin of the element is high and sharp-edged (pl. 40: 1*a*, 2*b*, *c*). Margins of the basal cavity rapidly converge in the proximity of the anterior end (pl. 40: 1*b*, 2*c*).

Remarks. — The investigated specimens differ from *Misikella hernsteini* in infolding of posterior margin; on the other hand the infolding is shallower than in *Misikella posthernsteini*. They differ from *Misikella posthernsteini* in quadrate outline, higher number of oral denticles, the above mentioned shallower infolding of posterior margin and in anterior denticle set perpendicular to the base. The described form is characterized by fairly stable features and narrow stratigraphic range. In morphology

it is transitional between *Misikella hernsteini* and *Misikella posthernsteini*. However, no transitional forms between *Misikella* sp. *A* and the two species were found so *Misikella* sp. *A* is treated as a seperate species here.

Occurrence. — In the Rhaetian (*pokornyi* and *friedli* Zone) cropping out at the foot of Siwiańskie Turnie in the Tatra Mts, samples 3 and 4 (see table 1 and pl. 37:2).

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KONODONTY Z RODZAJU *MISIKELLA* KOZUR ET MOCK, 1974 Z RETYKU REGLOWEGO TATR

Streszczenie

W utworach retyku reglowego (choczańskiego) odsłaniających się na zachodnim zboczu Doliny Chochołowskiej pod Siwiańskimi Turniami w Tatrach (pl. 37: 1, 2) odkryto najmłodsze konodonty triasowe. Są to *Misikella posthernsteini* Kozur i Mock, 1974 oraz nowa forma, którą opisano jako *Misikella* sp. *A* (pls 38—40). Formy te stanowią spathognathodidowy element aparatu konodontowego. Ewolucyjnie wywodzą się z *Misikella hernsteini* (Mostler, 1967), przy czym *Misikella* sp. A reprezentuje formę przejściową między *Misikella hernsteini* a *Misikella posthernsteini*.

Jednocześnie znalezione konodonty mają ważne znaczenie stratygraficzne. Gatunek *Misikella posthernsteini* jest skamieniałością wskaźnikową poziomu *posthernsteini* (retyk).

W odsłonięciu pod Siwiańskimi Turniami konodonty te znaleziono wspólnie z otwornicami przewodnimi dla retyku dolnego (poziom *pokornyi* i *friedli*) — w identycznej pozycji stratygraficznej jak *Misikella posthernsteini* w klasycznym odsłonięciu warstw kesseńskich w Hybe na Słowacji a także w górnotriasowych utworach formacji z Kuty na Nowej Gwinei (Papua).

Niniejsza praca została wykonana w ramach problemu międzyresortowego PAN MRII/3.

АНДЖЕЙ ГАЗЬДЗИЦКИ

КОНОДОНТЫ РОДА *MISIKELLA* KOZUR ET MOCK, 1974 ИЗ РЭТА НИЖНЕТАТРАНСКОЙ СЕРИИ

Резюме

В отложениях рэта нижнетатранской серии (хочский покров) которые обнажающихся на западном склоне Долины Хохоловской в районе Сивяньске Турне в Татрах (п. 37: 1—2) обнаружены самые молодые триасовые конодонты: *Misikella posthernsteini* Kozur & Mock, 1974 и новая форма *Misikella* sp. A (пл. 38—40). Формы эти являются спатогнатодидовым элементом конодонтового аппарата. В эволюционном отношении они происходят от *Misikella hernsteini* (Mostler, 1967), причём *Misikella* sp. *A* представляет переходную форму между *Misikella hernsteini* и *Misikella posthernsteini*. Обнаруженные конодонты имеют большое стратиграфическое значение. Вид *Misikella posthernsteini* является видом-индексом зоны *posthernsteini* (рэт). В обнажении в районе Сивяньске Турне эти конодонты найдены совместно с фораминиферами руководящими для нижнего рэта (зона *pokornyi* и *friedli*) — в идентичном стратиграфическом положении в каком находится *Misikella posthernsteini* в классическом обнажении кессенских слоёв Хыбе в Словакии, а также в верхнетриасовых отложениях свиты Кута Новой Гвинеи (Папуа).

EXPLANATION OF THE PLATES 37—40

Plate 37

1. Geological sketch-map of western slope of the Chochołowska Valley (inset shows its position in the Tatra Mts): after Guzik and Guzik (1958).
   1 Anisian-Ladinian dolomites; *2* Rhaetic limestones; *3* Eocene conglomerates; *4* boundary of tectonic units; arrowhead indicates locality of conodont-bearing Rhaetic limestones.
2. Exposure of the Rhaetic limestones at the foot of Siwiańskie Turnie.
   Arrowheads indicate conodont-bearing horizons; vertical bar indicates distribution of foraminifers *Triasina hantkeni* in this section; sampling: 1—10.

Plate 38

Misikella posthernsteini Kozur and Mock, 1974
Siwiańskie Turnie, the West Tatra Mts, Lower Rhaetian
(*pokornyi* and *friedli* Zone)

1, 2. *a*, *b* left lateral views; *1* from sample 3, *2* from sample 5, ZPAL C. X/1—2.
3. *a* right lateral view, *b* posterior view; sample 5, ZPAL C. X/3.
All figures are SEM micrographs × 200

Plate 39

Misikella posthernsteini Kozur and Mock, 1974
Siwiańskie Turnie, the West Tatra Mts, Lower Rhaetian
(*pokornyi* and *friedli* Zone)

1—3. Left lateral views; *1—2* from sample 3, *3* from sample 4, ZPAL C. X/4—6.
4. *a*, *b* right lateral views, *c* aboral view; sample 4, ZPAL C. X/7.
All figures are SEM micrographs × 200

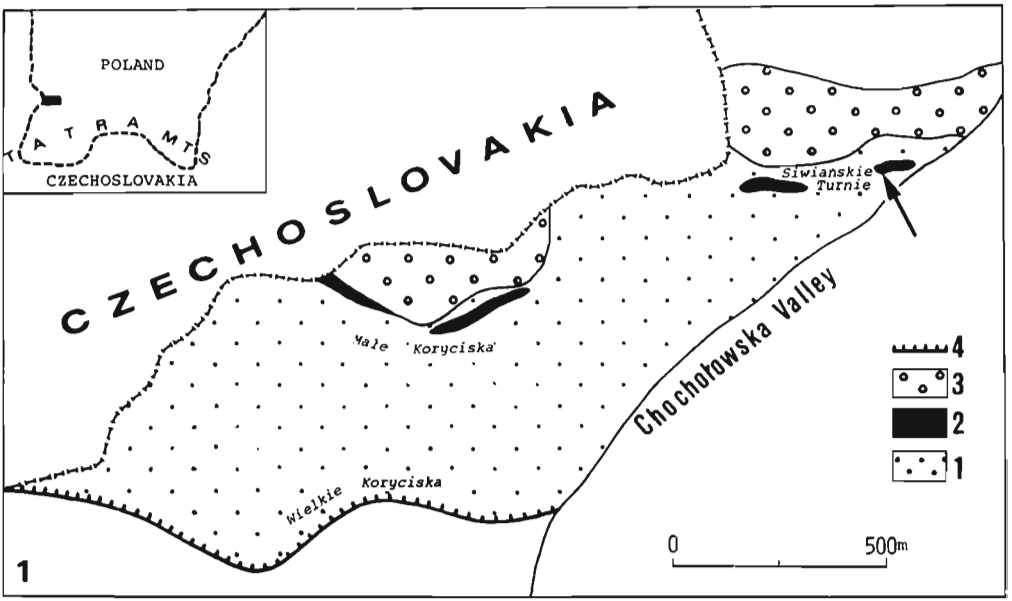
Plate 40

Misikella sp. *A*
Siwiańskie Turnie, the West Tatra Mts, Lower Rhaetian
(*pokornyi* and *friedli* Zone)

1. *a* right lateral view, *b* aboral view; sample 3, ZPAL C. X/9.
2. *a*, *c* left lateral views, *b* oral view; sample 4, ZPAL C. X/10.

Misikella posthernsteini Kozur and Mock, 1974
Siwiańskie Turnie, the West Tatra Mts, Lower Rhaetian
(*pokornyi* and *friedli* Zone)

3. Left lateral view; sample 3, ZPAL C. X/8.
All figures are SEM micrographs × 200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CZECHOSLOVAKIA
CZECHOSLOVAKIA
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Chochołowska Valley
Male Koryciska
Wielkie Koryciska
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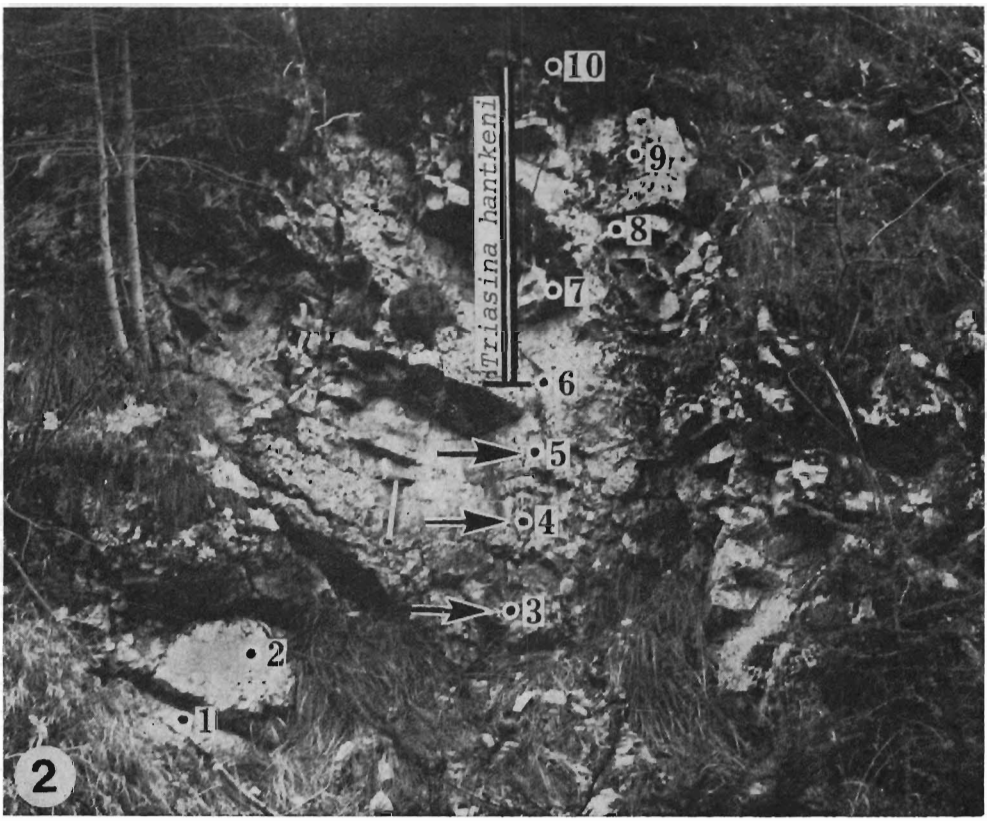
3
2
1
0
500m
1


Triasina hantkeni
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7
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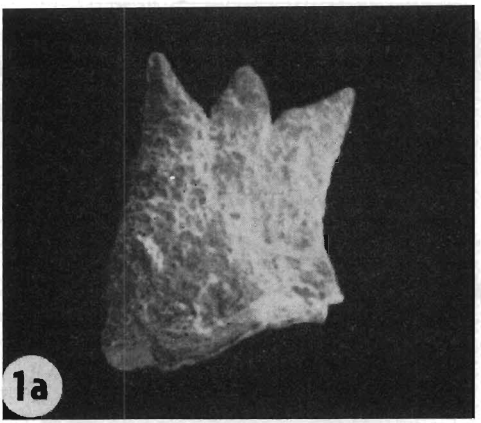
4
3
2
1
2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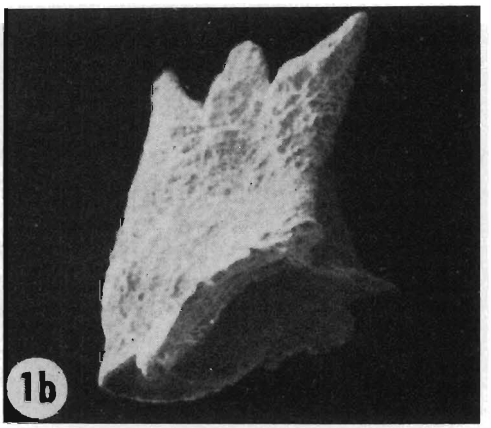
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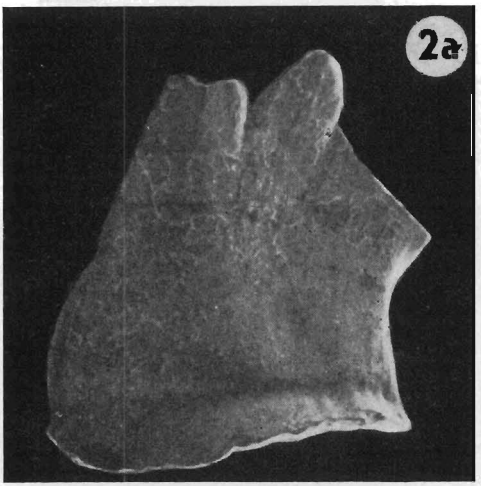
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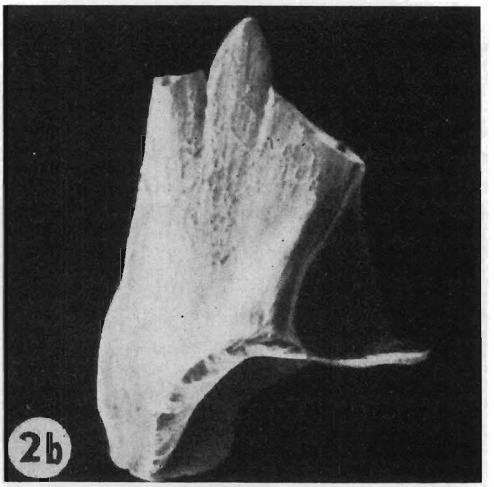
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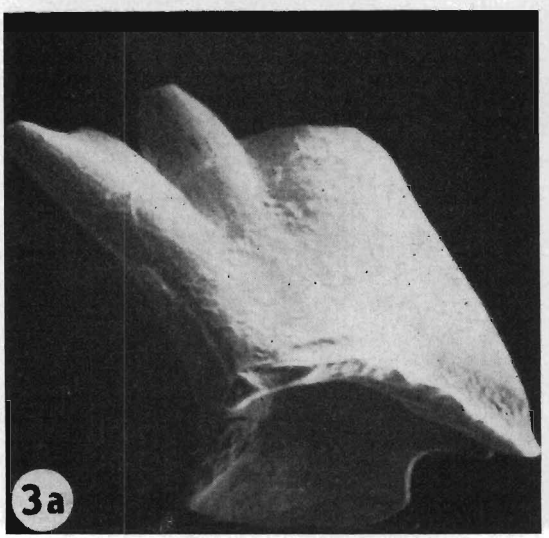
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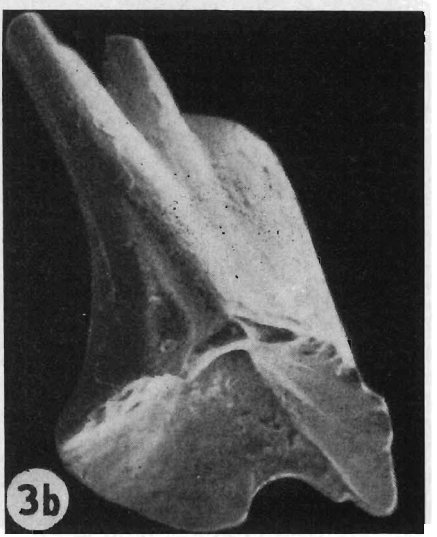
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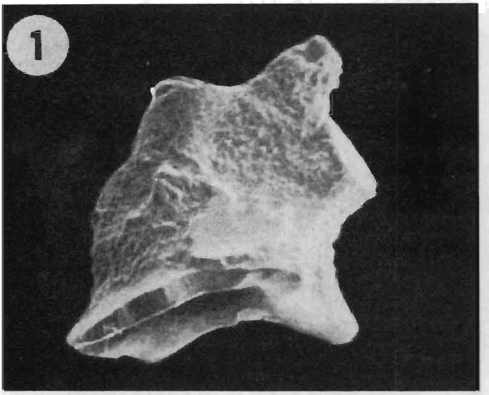
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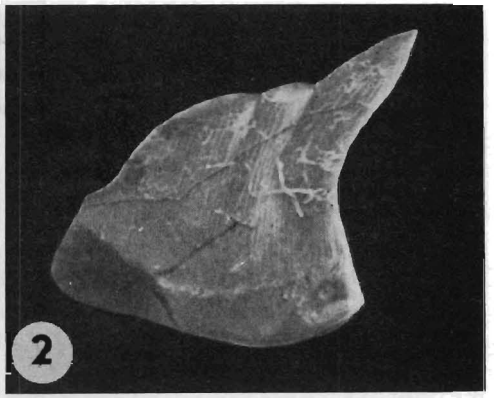
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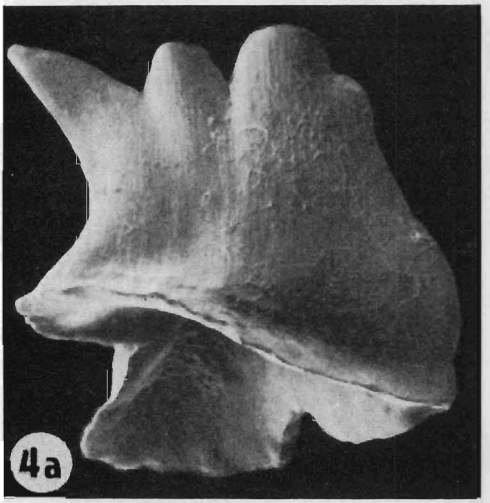
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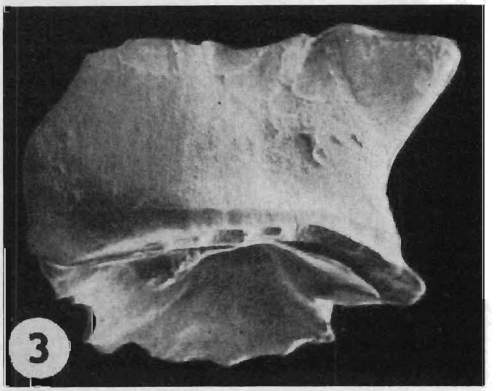
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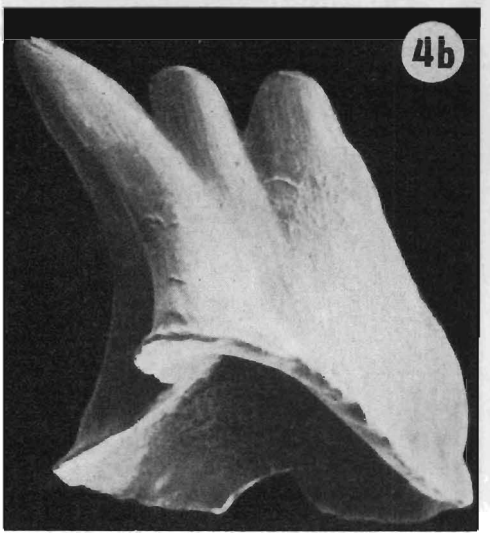
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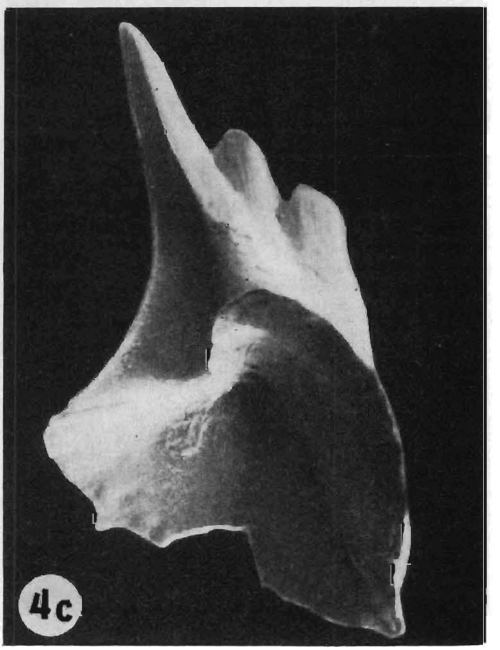
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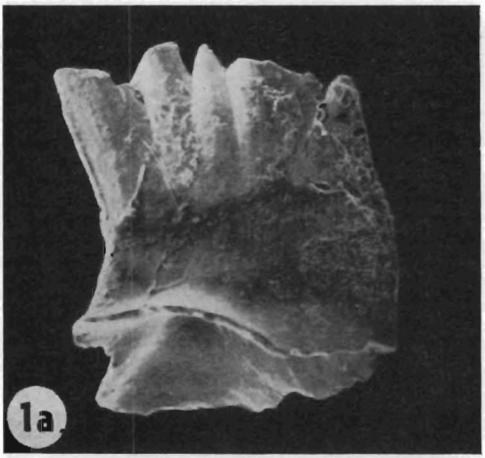
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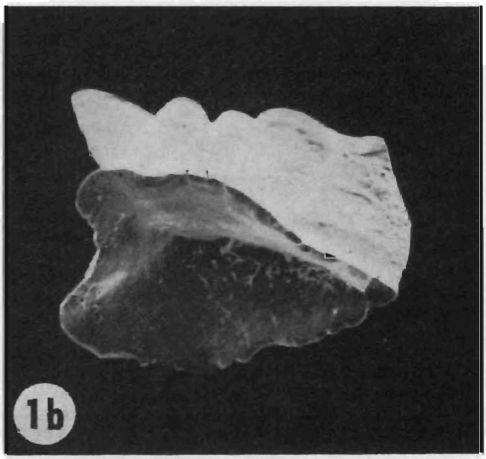
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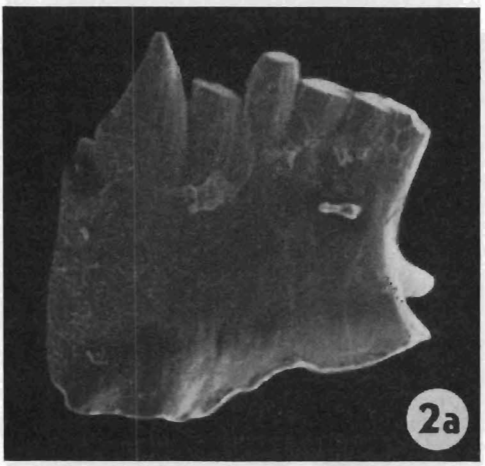
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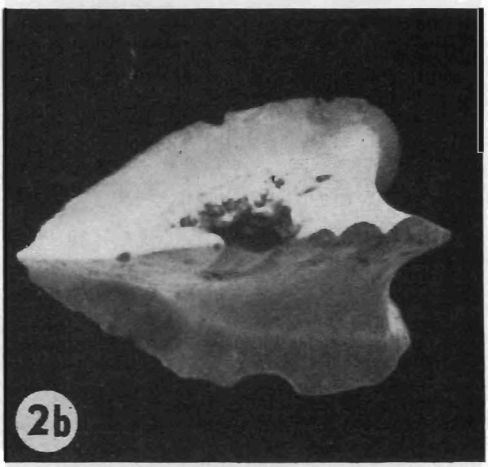
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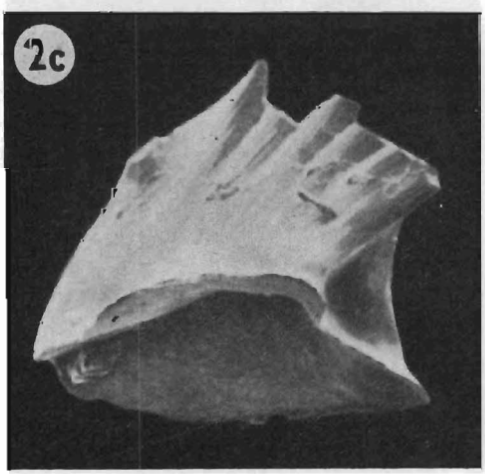
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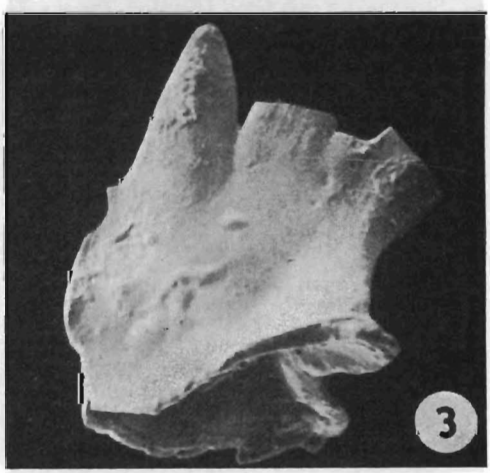
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