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STANISŁAW MATEUSZ GĄSIOROWSKI

RYNCHOLITY O CZTERODZIELNEJ I SZEŚCIODZIELNEJ POWIERZCHNI TYLNEJ

(Tabl. CXVI, CXVII i 4 fig.)

Rhyncholites with Quadri- and Sexa-Partite Posterior Surface

(Pl. CXVI, CXVII and 4 Figs.)

STRESZCZENIE

Górne szczęki obecnie żyjących łodzików i niektórych kopalnych głowonogów składały się z wapiennego zęba, zwanego rynchołitem, umocowanego w rogowym płacie lub płatach. Rynchołit był złączony z płatem swoją górną tylną powierzchnią. Rynchołity o zaokrąglonej jednolitej górnej tylnej powierzchni, i o tylnych brzegach górnej przedniej powierzchni skierowanych do przodu, były umocowane w jednym płacie: takie szczęki posiadają obecnie żyjące i niektóre kopalne łodziki począwszy od górnego paleozoiku. Rynchołity o górnej tylnej powierzchni podzielonej na trzy części przez dwa boczne grzbiety, i o tylnych brzegach górnej przedniej powierzchni skierowanych do tyłu, były umocowane w trzech płatach, mianowicie dwu bocznych i jednym środkowym. Takie szczęki są wyłącznie kopalne, występują od środkowego liasu do górnej kredy. Nie wiadomo, do jakich głowonogów należały. Pierwsza grupa rynchołitów jest nazywana *Rhyncholithes*, druga *Rhynchoteuthis*.

W obecnej pracy są opisane rynchołity, których górna tylna powierzchnia nie jest ani jednolita, ani trójdzielna, ale czterodzielna. Występują u nich na tej powierzchni dwa boczne grzbiety, a ponadto jeden środkowy grzbiet lub bruzda. Jest opisany także rynchołit z dwiema parami bocznych grzbietów i z jedną bruzdą środkową, a więc posiadający sześciodzielną górną tylną powierzchnię.

Pod wszystkimi względami oprócz kształtu górnej tylnej powierzchni rynchołity te mogą być zaliczone do grupy *Rhynchoteuthis*, a nawet do poszczególnych „rodzajów" i „gatunków". Wydaje się więc, że cztero- i sześciodzielność górnej tylnej powierzchni wynikała ze zmienności wewnątrzrodzajowej lub wewnątrzgatunkowej grupy *Rhynchoteuthis*.

Rynchołity o więcej niż trójdzielnej górnej tylnej powierzchni zostały znalezione w trzech spośród pięciu „rodzajów" grupy *Rhynchoteuthis*. W jednym z tych „rodzajów" pojawiają się i zanikają co najmniej pięć razy; w drugim co najmniej dwa razy; w trzecim co najmniej raz. W zespołach, w których występują, stanowią od 5 do 10% wszystkich okazów z grupy *Rhynchoteuthis*.

Jak było powiedziane wyżej, rynchołity o jednolitej górnej tylnej powierzchni były umocowane w jednym płacie, a rynchołity o trójdzielnej górnej tylnej powierzchni w trzech płatach. Dlatego można przy-

puszczać, że rynchołity o cztero- i sześciodzielnej górnej tylnej powierzchni były umocowane odpowiednio w czterech i sześciu płatach. Byłaby to ważna różnica anatomiczna. Jest także możliwe, że dodatkowe grzbiety i bruzdy nie odgraniczały pól przyczepienia poszczególnych płatów, ale służyły do wzmocnienia złączenia rynchołitu z płatem. Nie da się bezpośrednio rozstrzygnąć tej sprawy, ponieważ nie są znane okazy całych szczęk z rynchołitami o więcej niż trójdzielnej górnej tylnej powierzchni.

Pracownia Geologii Młodych Struktur
Polskiej Akademii Nauk
Kraków, ul. Senacka 3

A b s t r a c t. Some fossil rhyncholites possess quadri- or sexa-partite, and not uni- or tri-partite, posterior surface; their mode of attachment and its implications are considered.

The rhyncholites, i.e. upper teeth of some cephalopods, are arrow-like calcareous pieces. They are, as a rule, bilaterally symmetrical, the plane of symmetry being antero-posterior and dorso-ventral. The surface of a rhyncholite is divisible, in regard to function, into three parts (Fig. 1): lower surface, which was free and was directly connected with feeding; upper anterior surface which was probably also free; and upper posterior surface, by which the rhyncholite was set in the soft parts of the animal.

The setting was not immediate, but was realized by means of horny leaves. The rhyncholites with a unipartite rounded posterior surface and with the posterior edges of the anterior surface directed anteriorly were set by means of a single leaf. This may be seen in some Middle Trias forms (cf. R u t t e, 1962; M ü l l e r, 1963 a, b) and in the living *Nautilus* (S t e n z e l, 1964; C l o s s, 1967). Such rhyncholites were termed *Rhyncholithes*, and probably all belonged to the Nautiloidea. The rhyncholites with the posterior edges of the anterior surface directed posteriorly and with a posterior surface tripartite because of two lateral ridges were set by means of three leaves. The median part of the posterior surface, either concave or straight, was attached to the median leaf; the two lateral surfaces, usually concave or straight, were attached each to a lateral leaf. This may be seen in some Jurrasic and Cretaceous specimens (T i l l, 1906, 1907). Such rhyncholites were termed *Rhynchoteuthis*; it is not possible to indicate the cephalopods they belonged to; a review of opinions on this subject is given by C l o s s (1967).

There are, however, some specimens of rhyncholites where the posterior surface is developed in a somewhat different way. The difference consists in the presence either of a median concave stria, or of a more or less pronounced median ridge, or of a median stria together with two additional, latero-anterior, ridges, as schematically shown in Fig. 2. Thus the posterior surface becomes quadri- or sexa-partite, instead of tripartite.

The rhyncholites with a vaguely more than tripartite posterior surface were known for a long time (cf.: T i l l, 1906, 1907, 1908, 1909; S h i m a n s k y, 1947), but this character almost escaped attention, as

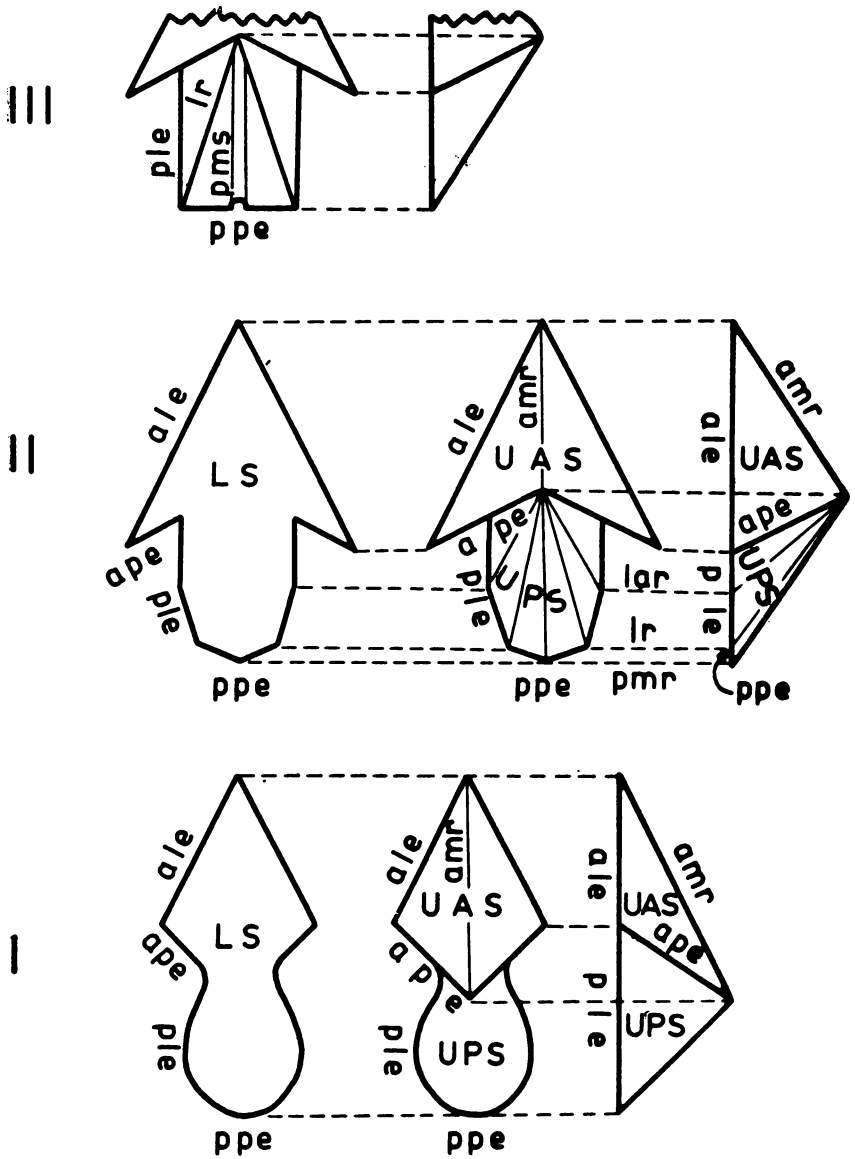
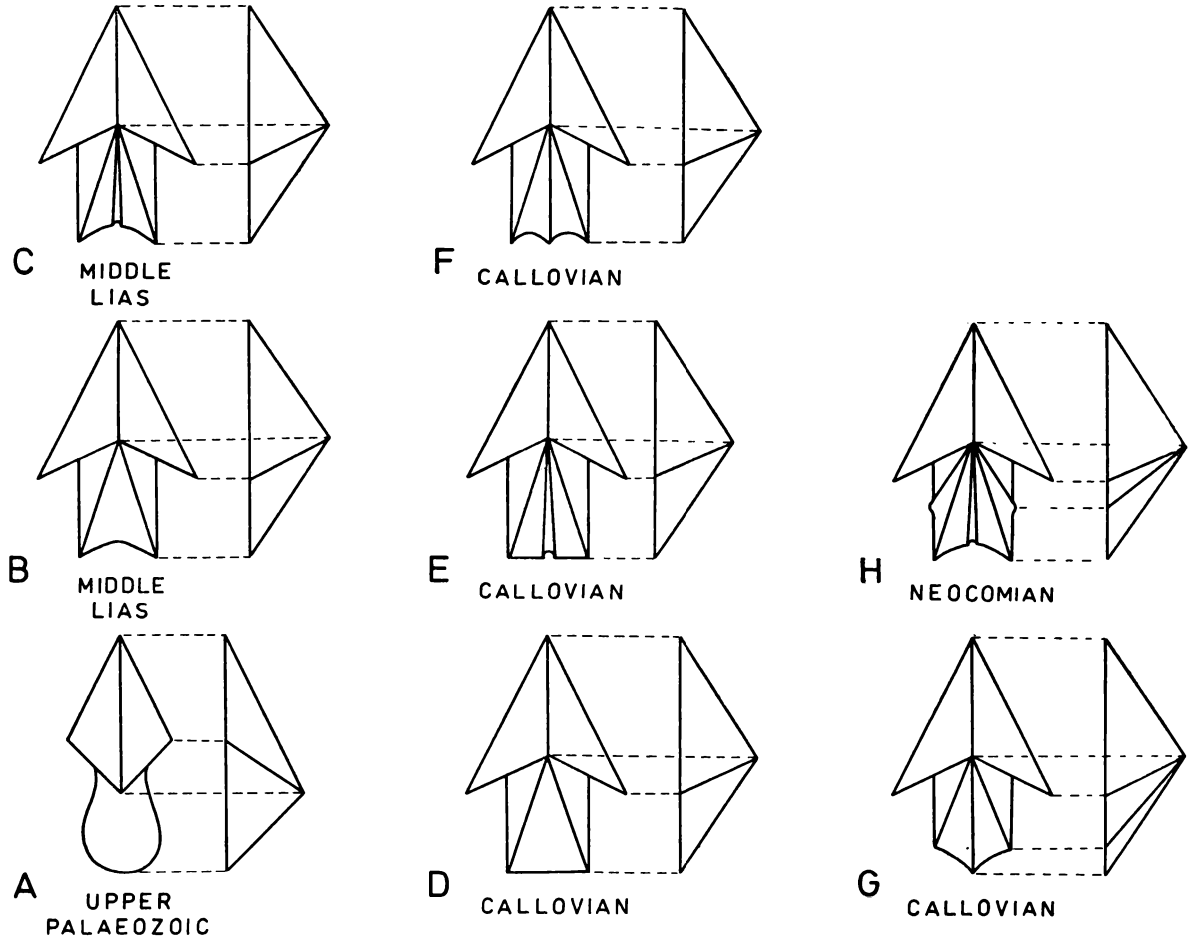


Fig. 1. Explanation of morphological terms used in the present paper. I — *Ryncholithes*; II, III — *Rhynchoteuthis*. ale — anterior lateral edge, arm — anterior median ridge, ape — posterior edge of the anterior surface, lar — latero-anterior ridge, lr — lateral ridge, LS — lower surface, ple — posterior lateral edge, pmr — posterior median ridge, pms — posterior median stria, ppe — posterior edge of the posterior surface, UAS — upper anterior surface, UPS — upper posterior surface

Fig. 1. Objaśnienie terminów morfologicznych użytych w obecnej pracy. I — *Rhyncholithes*; II, III — *Rhynchoteuthis*; ale — brzeg boczny przedni, amr — grzbiet środkowy przedni, ape — brzeg tylny górnej powierzchni przedniej, lar — grzbiet boczno-przedni, lr — grzbiet boczny, LS — powierzchnia dolna, ple — brzeg boczny tylny, pmr — grzbiet środkowy tylny, pms — prążek środkowy tylny, ppe — brzeg tylny górnej powierzchni tylnej, UAS — powierzchnia górna przednia, UPS — powierzchnia górna tylna


C
MIDDLE
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LIAS
E
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H
NEOCOMIAN
A
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PALAEOZOIC
D
CALLOVIAN
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CALLOVIAN

far as the author knows. In the present paper are described some specimens of rhyncholites with a distinctly more than tripartite posterior surface, and their meaning is considered.

The following is a list of all the hitherto known specimens of rhyncholites with a more than tripartite posterior surface. Specimens Nos. 3—13 and 25—38 derive from the Upper Callovian (sensu Arkell) uppermost part of the Lower Nodular Limestone of the Niedzica Series of the Pieniny Klippen Belt at Czajakowa Skała, South of Jaworki, Carpathians, Poland. The remaining specimens have been figured by Till (op. cit) and by Shimansky (op. cit.).

I. SPECIMENS WITH MEDIAN CONCAVE STRIA

No. 1. *Hadrocheilus oblongus*, Till 1907, Taf. XII, Fig. 9, p. 587—590: slight median concave stria. Middle Lias.

No. 2. *H.* cf. *gapensis*, Till 1908, Taf. XIX, Fig. 5, p. 586: slight median concave stria, described l.c. as „Schaftfurche scharf V-förmig". Middle Jurassic.

No. 3. Lower surface: non visible. Upper anterior surface: lateral slopes straight; distinct median ridge throughout the length. Upper posterior surface: central part formed of two almost straight surfaces intersecting in the plane of symmetry of the specimen, the intersection being marked by a slight median concave stria; lateral ridges clear and sharp. Dimensions vide Table 1. Except the median stria, all characters are those of *Leptocheilus*.

No. 4. Lower surface: in the anterior part, distinct median elongate convexity, posteriorly steeply inclined, elevated above the lateral edges, bordered on both lateral sides by flat or slightly concave areas situated at the level of the lateral edges; in the posterior part, median furrow. Upper anterior surface: rounded and uniform, somewhat convex in the plane of symmetry. Upper posterior surface: lateral ridges sharp and distinct, central part of the posterior surface slightly concave, with a median concave stria. Dimensions vide Table 1. Except the median stria, all characters are those of *Gonatocheilus oxfordiensis* (Till).

No. 5. Description as No. 4. Dimensions vide Table 1. Except the median stria and the value of the relation B/L, all characters are those of *Gonatocheilus oxfordiensis* (Till).

Fig. 2. Schematized rhyncholites in upper and side view, showing development of upper posterior surface, which is: A — unipartite; B — tripartite with central part concave; C — quadripartite due to median stria in the concave central part; D — tripartite with central part straight; E — quadripartite due to median stria in the straight central part; F, G — quadripartite due to median ridge; H — sexapartite due to median stria and two latero-anterior ridges (A: *Rhyncholithes*; B—H: *Rhynchoteuthis*)

Fig. 2. Schematycznie przedstawione rynchollity widziane od góry i z boku, ukazujące wykształcenie górnej tylnej powierzchni, która jest: A — jednodzielna; B — trójdzielna z wklęsłą częścią środkową; C — czterodzielna z powodu środkowego prążka we wklęsłej części środkowej; D — trójdzielna z płaską częścią środkową; E — czterodzielna z powodu środkowego prążka w płaskiej części środkowej; F, G — czterodzielna z powodu środkowego grzbietu; H — sześciodzielna z powodu środkowego prążka i dwu grzbietów boczno-przednich (A: *Rhyncholithes*; B—H: *Rhynchoteuthis*)

No 6 (Plate CXVII, Fig. 5). Lower surface: distinct median furrow in the posterior part, anterior part lacking. Upper anterior surface: lacking. Upper posterior surface: distinct lateral ridges, central part straight, with a distinct median concave stria. Dimensions vide Table 1. Except the median stria, all characters are those of *Gonatocheilus*.

No. 7. Description and comparison as No. 6. Dimensions vide Table 1.

No. 8. Lower surface: in the anterior part, distinct median elongate convexity bordered on both lateral sides by concavities; in the posterior part, median furrow bordered on both lateral sides by concavities. Upper anterior surface: partly obliterated. Upper posterior surface: distinct sharp lateral ridges, central part of posterior surface straight with distinct sharp median concave stria continued by the median furrow on the lower surface; posterior edge straight, with incision at the junction of the median stria of the upper surface with the median furrow of the lower surface. Dimensions vide Table 1. Except the median stria, all characters are those of *Gonatocheilus*.

No. 9. Lower surface: in the anterior part, median elongate convexity; otherwise obliterated. Upper anterior surface: rounded and uniform. Upper posterior surface: lateral ridges distinct, central part straight, with a median concave stria. Dimensions vide Table 1. Comparison as No. 8.

No. 10 (Plate CXVII, Fig. 6—8). Description as No. 4, excepted that the median convexity in the anterior part of the lower surface is less steep both anteriorly and posteriorly. Dimensions vide Table 1. Comparison as No. 8.

No. 11. Description and comparison as No. 10. Dimensions vide Table 1.

No. 12. Lower surface: in the anterior part, median elongate convexity; in the posterior part, median furrow; otherwise obliterated. Upper anterior surface: partly obliterated. Upper posterior surface: description as No. 9. Dimensions vide Table 1. Comparison as No. 8.

No. 13. Lower surface: in the anterior part, median elongate convexity becoming posteriorly very slightly steeper, somewhat elevated above the lateral edges, bordered on both lateral sides by straight areas situated at the level of the lateral edges; in the posterior part, median furrow. Upper anterior surface: rounded and uniform, convex in the plane of symmetry. Upper posterior surface: distinct lateral ridges, central part straight, with a median concave stria. Dimensions vide Table 1. Except the median stria, all characters are those of *Gonatocheilus*; the shape of the lower surface approaches that of Duplofracti, which are a group distinguished by Till (1907) in the „genus" *Gonatocheilus*, and also of *Akidocheilus* (?) *transiens* Till, which is a „species" transitional between *Gonatocheilus* and *Akidocheilus*; but dimensions and their relations are different from both the known Duplofracti and *A.* (?) *transiens*.

No. 14. *Hadrocheilus valanginiensis*, Till 1907, Taf. XII, Fig. 3, p. 577: slight median concave stria, described l.c. as „Haftlinie des Mittelflügels", Lower Neocomian.

No. 15. *H. latohasta*, Till 1909, Taf. XIII, Fig. 15, p. 416: slight median concave stria, described l.c. as „leichte lineare Einsenkung". Lower Neocomian.

No. 16. *H. inaequalis*, Till 1909, Taf. XIII, Fig. 17, p. 420: slight median concave stria. Lower Neocomian.

No. 17. *H. gibberlongus*, Till 1909, Taf. XIII, Fig. 23, p. 423: slight median concave stria.

No. 18. *H. gibberiformis,* Till 1909, Taf. XIII, Fig. 25, p. 424: slight median concave stria. Lower Neocomian.

No. 19. *H. duplogibber,* Till 1909, Taf. XIII, Fig. 27, p. 422: slight median concave stria. Lower Neocomian.

No. 20. *Rhynchotheutis heneggeri,* Till 1906, Taf. IV, Fig. 8, p. 109—110: slight median concave stria (*Hadrocheilus heneggeri,* Till 1907). Upper Neocomian.

No. 21. *Rhynchotheutis squammatus,* Till 1906, Taf. IV, Fig. 11, p. 110—111: slight median concave stria (*Hadrocheilus squammatus,* Till 1907). Upper Neocomian.

No. 22. *Rhynchotheutis silesiacus,* Till 1906, Taf. IV, Fig. 17, p. 112—113: slight median concave stria (*Hadrocheilus silesiacus,* Till 1907). Upper Neocomian.

No. 23. *Erlangericheilus insignis,* Shimansky 1947, Fig. 1, p. 1478: distinct median concave stria. The „genus" *Erlangericheilus,* defined on two specimens, is possibly based on a monstrosity, namely an immense hypertrophy of the posterior part. Aptian.

No. 24. *Hadrocheilus convexoides,* Till 1908, Taf. XIX, Fig. 10, p. 589: median stria or furrow, described l.c. as „Schaftfurche... deutlich V-förmig". Stratigraphical position unknown.

II. SPECIMENS WITH MEDIAN RIDGE

No 25 (Plate CXVI, Fig. 1—3). Lower surface: wholly elevated above the edges, except near the posterior edge, where it is almost straight and situated about the level of the edges; distinct median elongate ridge with a conical convexity whose top is 3,7 mm from the anterior point and 6,5 mm from the posterior edge; the anterior slope of this convexity is longer than the posterior one; in lateral view, the lower surface is clearly concave between the anterior point and the conical convexity, slightly concave on the other side of the conical convexity, becoming almost straight towards the posterior edge. Upper anterior surface: secondarily deformed, most distinctly so on the right side; strongly convex in the plane of symmetry. Upper posterior surface: distinct though rounded lateral ridges; a distinct rounded median ridge, slightly diverging to the left from the plane of symmetry of the specimen near the posterior edge, and indistinctly dividing in two; two shallow furrows between the median and lateral ridges; posterior edge generally convex. Dimensions vide Table 1. Except the shape of the posterior surface, all characters are those of *Hadrocheilus.* The conical convexity of the lower surface resembles that of *H. punctatus* Till; all the remaining characters agree best with *H. gibber* Till.

No 26 (Plate CXVI, Fig. 4—6). Lower surface: distinct strong median ridge throughout the length, situated at the level of the lateral edges or slightly elevated, bordered on both sides by deep lateral concavities; in lateral view slightly concave. Upper anterior surface: distinct median ridge throughout the length. Upper posterior surface: distinct lateral ridges, central part almost straight, with a distinct low median ridge, situated somewhat to the right of the plane of symmetry of the specimen. Dimensions vide Table 1. Except the shape of the central part of the posterior surface, all characters are those of *Leptocheilus*; the relations of dimensions are different than in the hitherto known „species"

No. 27 (Plate CXVI, Fig. 7—9). Lower surface: anterior part lacking, distinct strong median ridge throughout the remaining part of the length, slightly elevated above lateral edges, bordered on both sides by deep lateral concavities. Upper anterior surface: partly obliterated. Upper posterior surface: distinct and sharp lateral ridges, and a distinct, sharp and high median ridge, situated somewhat to the left of the plane of symmetry of the specimen; between the median and lateral ridges the central part of the posterior surface steeply concave. Dimensions vide Table 1. Except the median posterior ridge, all characters are those of *Leptocheilus*.

No 28 (Plate CXVII, Fig. 9—12). Lower surface: in the anterior part, distinct elongate median convexity posteriorly becoming steeper, elevated above the lateral edges, bordered on both sides by lateral areas, straight and situated at the level of the lateral edges; in the posterior part, median furrow. Upper anterior surface: rounded and uniform, slightly convex in the plane of symmetry. Upper posterior surface: lateral ridges distinct and sharp; central part of posterior surface almost straight, with a very low median ridge; growth lines at the median ridge, and also the posterior edge, bent posteriorly; slight median concave stria at the top of the ridge. Dimensions vide Table 1. Except the shape of the central part of the posterior surface, all characters are those of *Gonatocheilus brunneri* (O o s t e r).

No. 29. Description as No. 28, excepted that the median posterior ridge is still lower and devoid of a median concave stria. Dimensions vide Table 1. Except the median ridge and the value of the relation B/L, all characters are those of *Gonatocheilus brunneri* (O o s t e r).

No. 30. Description as No. 28, excepted that the median posterior ridge is slight and low and devoid of median concave stria. Dimensions vide Table 1. Except the median ridge, all characters are those of *Gonatocheilus*; the shape of the lower surface and of the upper anterior surface are identical with those of *G. brunneri* (O o s t e r), but relations of dimensions are different.

No. 31 (Plate CXVII, Fig. 1—4). Lower surface: in the anterior part, distinct median elongate convexity posteriorly not becoming steeper, slightly elevated above the lateral edges, bordered on both sides by straight lateral areas situated at the level of the lateral edges; in the posterior part, median furrow. Upper anterior surface: rounded and uniform, convex in the plane of symmetry. Upper posterior surface: distinct lateral ridges, central part almost straight, with a low distinct median ridge. Dimensions vide Table 1. Except the median posterior ridge, all characters are those of *Gonatocheilus*; the shape of the lower surface resembles that of Duplofracti and *Akidocheilus* (?) *transiens* (cf. supra No. 13); dimensions and their relations are different from those of the hitherto known Duplofracti, while they agree with those of *A.* (?) *transiens*; however, the central part of the posterior surface is not concave, which is an essential difference from *Akidocheilus* including *A.* (?) *transiens*.

No. 32. Description and comparison as No. 31. Dimensions vide Table 1.

No. 33. Description as No. 31, excepted that the posterior median ridge is very low and broad. Dimensions vide Table 1. Except the posterior median ridge, all characters are those of *Gonatocheilus*; the shape of the lower surface is that of Duplofracti and *Akidocheilus* (?) *transiens*, but dimensions and their relations are different.

No. 34. Lower surface: almost obliterated. Upper anterior surface: partly obliterated. Upper posterior surface: lateral ridges distinct, central part of posterior surface straight, with a low median ridge. Dimensions vide Table 1. Except the posterior median ridge, all characters are those of *Gonatocheilus*.

No. 35. Lower surface: in the anterior part, median elongate convexity; in the posterior part, median furrow bordered by convexities on both sides; otherwise obliterated. Upper anterior surface: partly obliterated. Upper posterior surface: distinct lateral ridges; central part straight, with a slight low ridge. Dimensions vide Table 1. Comparison as No. 34.

No. 36. Lower surface: in the anterior part, median elongate convexity elevated above the lateral edges; otherwise obliterated. Upper anterior surface: rounded and uniform. Upper posterior surface: distinct lateral ridges, central part straight, with a very low median ridge. Dimensions vide Table 1. Comparison as No. 34.

No. 37 (Plate CXVI, Fig. 10—12). Lower surface partly obliterated; description otherwise as No. 33, excepted that the median posterior ridge is very low. Dimensions vide Table 1. Comparison as No. 33.

No. 38. Description as No. 31, excepted that the upper anterior surface is partly obliterated, the convexity in the anterior part of the lower surface is posteriorly somewhat steeper thus resembling No. 28, and the median posterior ridge is slight. Dimensions vide Table 1. Comparison as No. 33.

No. 39. *Rhynchotheutis oxfordiensis,* Till 1906, Taf. V, Fig. 44, 47, p. 141—142: distinct low median ridge, described l.c. as „eine Linie" (*Gonatocheilus oxfordiensis,* Till 1907). Oxfordian.

III. SPECIMEN WITH MEDIAN STRIA AND LATERO-ANTERIOR RIDGES

No. 40. *Rhynchotheutis teschenensis,* Till 1906, Taf. IV, Fig. 4 (upper view), Fig. 5 (side view), p. 107—108: besides the usual lateral ridges delimiting the central and lateral parts of the posterior surface, there occur a pair of latero-anterior ridges on the lateral parts of the posterior surface, and a median stria in its central part, described l.c. as „Längslinie" (*Hadrocheilus teschenensis,* Till 1907). Upper Neocomian.

It may be seen that the specimens listed above possess all the characters of the *Rhynchoteuthis,* excepted the form of the posterior surface. They may be attributed even to particular „genera" and „species" of this group. It seems therefore more justified to consider the quadri- and sexa-partite division of the posterior surface as due to intragenerical or intraspecific variability of the *Rhynchoteuthis,* than to erect on these characters new groups of rhyncholites, equal in rank to the *Rhyncholithes* and *Rhynchoteuthis.*

Until the systematical position of forms with a more than tripartite division of the posterior surface is definitely decided, it may be advisable to denote them by some symbols. Thus one might write e.g. „*Gonatocheilus* (3)" meaning usual forms with a tripartite posterior surface, and

„*Gonatocheilus* (4)" meaning forms with a quadripartite posterior surface, but otherwise possessing all characters of *Gonatocheilus*.

The two lateral ridges of the posterior surface of a usual *Rhynchoteuthis* delimit the surfaces of attachment of particular leaves. Therefore it may be supposed that the forms developed beside these ridges — median ridge, median concave stria, latero-anterior ridges — also expressed the mode of attachment. The question cannot be decided directly, as none of the specimens with a more than tripartite division of the posterior surface were found preserved together with their horny leaves.

Until such specimens are found, two different functions may be attributed to the more than tripartite division of the posterior surface. A median ridge or concave stria may have delimited surfaces of attachment of particular leaves, the total number of leaves being four instead of the usual three. In an analogous way, rhyncholites with a median stria and two additional, latero-anterior ridges, may be considered to have been attached to six leaves. Another possibility is that the presence of a median ridge or stria and of latero-anterior ridges, by augmenting the extent of the posterior surface, enabled a stronger attachment to the leaves, whose total number remained three (Fig. 3). This was probably the possibility envisaged by Till, when, in the description of *Hadrocheilus valanginiensis*, he used the expression „Haftlinie des Mittelflügels" (1907, p. 577).

The former, and more radical, possibility, may appear more convincing in the case of specimens Nos. 25—27 and 31, where the median ridge is well developed. It may be argued,that, since the median ridge is as well developed as the two lateral ones which delimited the surfaces of attachment of particular leaves, it should have possessed the same function.

The latter possibility may seem more appealing in the case of the remaining specimens, where there occur either concave striae, or ridges which are low, rounded and rather vague, generally much worse pronounced than the usual lateral ridges.

It cannot be excluded that the former possibility was valid in some cases, while the latter was in the other.

It seems that the strength of the jaw should have depended, among other factors, on the extent of the surface used for attachment of the rhyncholite to the leaves. This was not connected with the number of leaves. The extent of the surface of attachment, taken in relation to the volume of the posterior part of the rhyncholite, was the smallest in the specimens with unipartite posterior surface (*Rhyncholithes*), greater in the specimens with tripartite posterior surface (usual *Rhynchoteuthis*), and greater still in the specimens with a quadri- or sexa-partite posterior surface (cf. Fig. 2, 3). In this respect, therefore, the last specimens were more firmly attached than any other.

However, the efficiency of the jaw should have depended, not so much on the general strength of attachment of the rhyncholite to the leaves, as on the resistance to particular stresses acting in the course of feeding. These are of two types: stresses situated in the antero-posterior plane of symmetry, forcing the upper tooth usually either upwards (when cutting or crushing food) or forwards (when tearing away); and stresses situated otherwise, acting when food was being crushed or munched. In carnivorous animals, such as cephalopods, the former stresses were probably stronger and more violent than the latter. The jaws with *Rhyncholithes*, attached to a single leaf by a uniformly rounded surface,

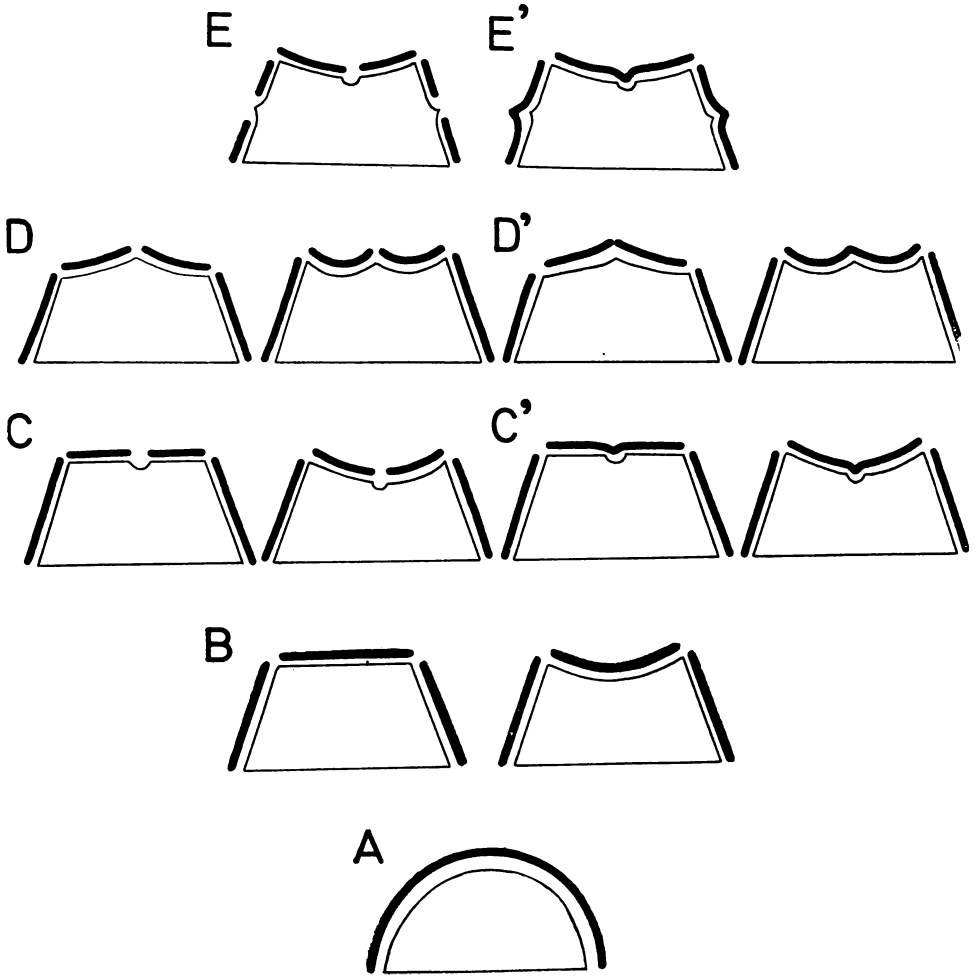

Fig. 3. Cross-sections of jaws of cephalopods, passing through posterior part of rhyncholite, vertical and perpendicular to the plane of symmetry. Thin lines: outline of calcareous rhyncholite, thick lines: horny leaves. A — unipartite posterior surface, attached to one leaf; B — tripartite posterior surface, attached to three leaves; C, D — quadripartite posterior surface, shown as attached to four leaves; C′, D′ — quadripartite posterior surface, shown as attached to three leaves; E — sexapartite posterior surface, shown as attached to six leaves; E′ — sexapartite posterior surface, shown as attached to three leaves (A: *Rhyncholithes*; B—E′: *Rhynchoteuthis*)

Fig. 3. Przekroje szczęk głowonogów przechodzące przez tylną część ryncholitu, pionowe i prostopadłe do płaszczyzny symetrii. Linie cienkie: zarys wapiennego ryncholitu, linie grube: rogowe płaty. A — jednodzielna powierzchnia tylna przyczepiona do jednego płatu; B — trójdzielna powierzchnia tylna przyczepiona do trzech płatów; C, D — czterodzielna powierzchnia tylna, pokazana jako przyczepiona do czterech płatów; C′, D′ — czterodzielna powierzchnia tylna, pokazana jako przyczepiona do trzech płatów; E — sześciodzielna powierzchnia tylna, pokazana jako przyczepiona do sześciu płatów; E′ — sześciodzielna powierzchnia tylna, pokazana jako przyczepiona do trzech płatów (A: *Rhyncholithes*; B—H′: *Rhynchoteuthis*)

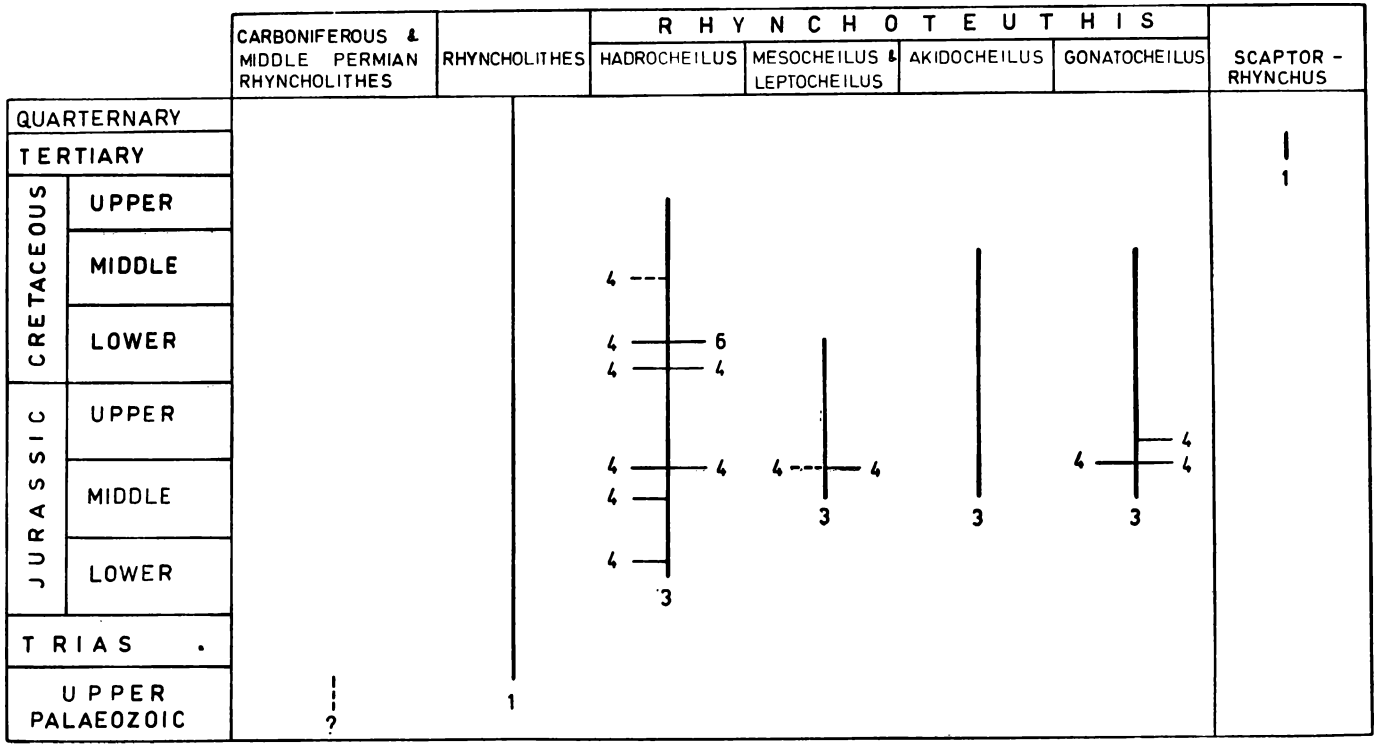

Fig. 4. Stratigraphical distribution of rhyncholites. Numbers indicate the division of the posterior surface: 1 — unipartite, 3 — tripartite, 4 — quadripartite, 6 — sexapartite. For each „genus", the presence of specimens with median stria is indicated to the left, and of specimens with median and latero-anterior ridges, to the right. The „genera" *Mesocheilus* and *Leptocheilus* are not distinguished because of great similarity and morphological transitions

Fig. 4. Rozmieszczenie stratygraficzne ryncholitów. Cyfry oznaczają podział powierzchni tylnej: 1 — jednodzielna, 3 — trójdzielna, 4 — czterodzielna, 6 — sześciodzielna. Dla każdego „rodzaju", obecność okazów z prążkiem środkowym jest zaznaczona na lewo, a okazów z grzbietem środkowym lub grzbietami boczno-przednimi, na prawo

should have been less resistant to all these stresses than the jaws with *Rhynchoteuthis* attached to three leaves, as shown in Fig. 3. If the *Rhynchoteuthis* with quadripartite posterior surface were attached to three leaves, the resistance to all stresses would have been probably still greater. If these *Rhynchoteuthis* were attached to four leaves, the jaws may have been less resistant to the important stresses directed upwards in the antero-posterior plane of symmetry, which would have tended to force the tooth between the leaves, i.e. in the weakest area (cf. Fig. 3).

The division of the posterior surface into more than three parts is present (Fig. 4) in three of the major units of the *Rhynchoteuthis,* called „genera", which are established on characters directly connected with the mode of feeding, but which nevertheless may not agree with taxonomical classification. The division into more than three parts is present in only a few „species" as hitherto conceived; but these „species", owing to the practice of erecting a separate one for almost each specimen found, seem to be much too numerous, as suggested by the studies of Müller (1963b) on the Middle Trias *Rhyncholithes* and of the present author on the Jurassic *Rhynchoteuthis.* It will possibly appear that specimens with a posterior surface divided into more than three parts are present in a majority of species.

The vertical distribution of the more than tripartite posterior surface seems to have been discontinuous (Fig. 4). Specimens possessing this character appear and disappear several times in the „genus" *Hadrocheilus,* at least twice in the „genus" *Gonatocheilus,* and at least once in the „genus" *Leptocheilus.* There were probably periods when there were no *Rhynchoteuthis* with a more than tripartite posterior surface.

* *

In the rhyncholites taken as a whole, the order of the first appearance seems to have been the following (Fig. 2, 4):

1. unipartite posterior surface — Upper Palaeozoic;
2. tripartite posterior surface — Middle Lias;
3. quadripartite posterior surface due to a median stria — Middle Lias;
4. quadripartite posterior surface due to a median ridge — Callovian;
5. sexapartite posterior surface — Neocomian.

It may be seen that during the history of the rhyncholites the number of the divisions of the posterior surface has been becoming greater.

It is difficult to establish the relative frequence of specimens with a more than tripartite posterior surface. In the Upper Callovian of the Pieniny Klippen Belt they constitute between 7 and 10 per cent of all specimens of the *Rhynchoteuthis.* In other assemblages, to judge from the published data, they were not more frequent, and probably much rarer.

Thus the rhyncholites with a more than tripartite posterior surface do not seem to have been very successful.

Laboratory of Geology of Young Structures
of the Polish Academy of Sciences
Kraków, Senacka 3

WYKAZ LITERATURY
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OBJAŚNIENIE TABLIC
EXPLANATION OF PLATES

Tablica — Plate CXVI

Fig. 1. Okaz nr 25 od dołu. ×3,8
Fig. 2. Ten sam okaz od góry: widoczny grzbiet środkowy tylny. ×3,8
Fig. 3. Ten sam okaz z boku. ×3,8
Fig. 4. Okaz nr 26 od dołu. ×2,8
Fig. 5. Ten sam okaz od góry: widoczny grzbiet środkowy tylny. ×2,8
Fig. 6. Ten sam okaz z boku. ×2,8
Fig. 7. Okaz nr 27 od dołu. ×4
Fig. 8. Ten sam okaz od góry: widoczny grzbiet środkowy tylny. ×3,2
Fig. 9. Ten sam okaz z boku. ×3,5
Fig. 10. Okaz nr 37 od góry: widoczny grzbiet środkowy tylny. ×4
Fig. 11. Ten sam okaz z boku. ×3,8
Fig. 12. Ten sam okaz, środkowa część górnej tylnej powierzchni: widoczny grzbiet środkowy. ×4

Wszystkie okazy pochodzą z najwyższej części (górny kelowej) wapienia bulastego dolnego serii niedzickiej pienińskiego pasa skałkowego w Czajakowej Skale koło Jaworek.

Fig. 1. Specimen No. 25. Lower view. ×3.8
Fig. 2. Same specimen. Upper view, showing median posterior ridge. ×3.8
Fig. 3. Same specimen. Side view. ×3.8
Fig. 4. Specimen No. 26. Lower view. ×2.8
Fig. 5. Same specimen. Upper view, showing median posterior ridge. ×2.8
Fig. 6. Same specimen. Side view. ×2.8
Fig. 7. Specimen No. 27. Lower view. ×4
Fig. 8. Same specimen. Upper view, showing median posterior ridge. ×3.2

Fig. 9. Same specimen. Side view. X3.5
Fig. 10. Specimen No. 37. Upper view, showing median posterior ridge. X4
Fig. 11. Same specimen. Side view. X3.8
Fig. 12. Same specimen. Central part of posterior surface, showing median ridge. X4

All specimens derive from the Upper Callovian uppermost part of the Lower Nodular Limestone of the Niedzica Series of the Pieniny Klippen Belt at Czajakowa Skała S of Jaworki, Carpathians, Poland.

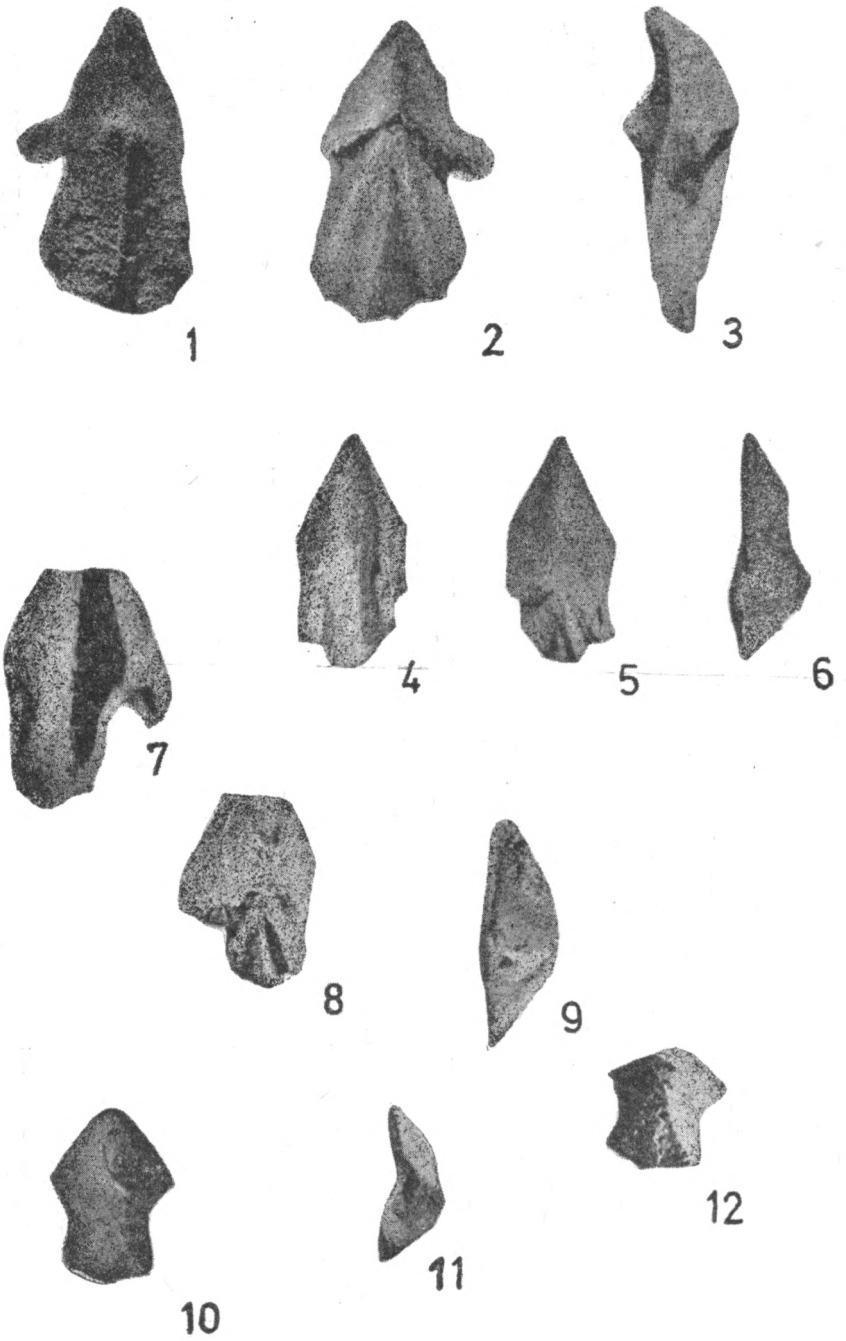
Tablica — Plate CXVII

Fig. 1. Okaz nr 31 od dołu; po lewej stronie widoczna tylna część dolnej powierzchni rynchollitu z rodzaju *Leptocheilus*. X3,4
Fig. 2. Ten sam okaz od góry: widoczny grzbiet środkowy tylny. X3,4
Fig. 3. Ten sam okaz z boku. X3,4
Fig. 4. Ten sam okaz, środkowa część górnej tylnej powierzchni: widoczny grzbiet środkowy. X3,4
Fig. 5. Okaz nr 6, środkowa część górnej tylnej powierzchni: widoczny prążek środkowy. X3
Fig. 6. Okaz nr 10 od dołu. X4
Fig. 7. Ten sam okaz od góry: widoczny prążek środkowy. X3
Fig, 8. Ten sam okaz, środkowa część górnej tylnej powierzchni: widoczny prążek środkowy. X4
Fig. 9. Okaz nr 28 od dołu. X3,5
Fig. 10. Ten sam okaz od góry: widoczny grzbiet środkowy tylny. X3.5
Fig. 11. Ten sam okaz z boku. X 3,2
Fig. 12. Ten sam okaz, środkowa część górnej tylnej powierzchni: widoczne linie przyrostowe wygięte do tyłu na grzbiecie. X3,2

Wszystkie okazy pochodzą z najwyższej części (górny kelowej) wapienia bulastego dolnego serii niedzickiej pienińskiego pasa skałkowego w Czajakowej Skale koło Jaworek.

Fig. 1. Specimen No. 31. Lower view; at the left, posterior part of the lower surface of a *Leptocheilus*. X3,4
Fig. 2. Same specimen. Upper view, showing median posterior ridge. X3,4
Fig. 3. Same specimen. Side view. X3,4
Fig. 4. Same specimen. Central part of posterior surface, showing median ridge. X3,4
Fig. 5. Specimen No. 6. Central part of posterior surface, showing median concave stria. X3
Fig. 6. Specimen No. 10. Lower view. X4
Fig. 7. Same specimen. Upper view, showing median posterior stria. X3
Fig. 8. Same specimen. Central part of posterior surface, showing median concave stria. X4
Fig. 9. Specimen No. 28. Lower view. X3,5
Fig. 10. Same specimen. Upper view, showing median posterior ridge. X3,3
Fig. 11. Same specimen. Side view. X3,2
Fig. 12. Same specimen. Central part of posterior surface, showing growth lines posteriorly bent at the ridge. X3,2

All specimen derive from the Upper Callovian uppermost part of the Lower Nodular Limestone of the Niedzica Series of the Pieniny Klippen Belt at Czajakowa Skała S of Jaworki, Carpathians, Poland.



S. Gąsiorowski



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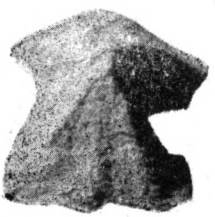

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S. Gąsiorowski

Tabela 1 — Table 1

Dimensions of specimens from the Upper Callovian of the Carpathians. Linear measurements in millimeters. Italics indicate approximate values.
Symbols sensu Till (1907)

Wymiary okazów z górnego keloweju Karpat. Wymiary liniowe w milimetrach. Symbole według Till'a (1907). Wartości przybliżone wskazane kursywą

Specimen No. Okaz nr	3	4	5	6	7	8	9	10	11	12	13	25	26	27	28	29	30	31	32	33	34	35	36	37	38
L	7,0	8,0	6,0	—	—	6,3	4,0	5,5	10,0	9,7	8,3	11,0	11,0	*11,0*	6,5	9,3	5,0	11,0	7,6	8,0	6,0	8,0	4,0	5,5	5,3
l_1	5,5	6,3	5,0	—	—	5,3	2,7	5,0	8,3	8,0	8,0	5,0	7,5	*8,0*	5,5	7,0	4,2	10,0	6,3	6,3	4,7	—	3,0	4,5	4,5
l_2	2,0	3,3	2,8	7,0	3,0	3,0	1,8	3,5	5,3	6,7	3,5	7,0	4,5	4,0	4,5	5,6	2,0	6,0	3,5	4,0	2,8	4,0	1,8	3,0	2,2
a	5,5	6,3	5,0	—	—	5,3	2,7	5,0	9,0	7,7	8,2	4,5	8,0	*8,0*	5,0	6,7	4,0	9,0	6,2	6,3	6,0	—	3,0	4,5	4 5
s	*6,7*	*7,0*	5,5	—	—	*4,5*	*4,0*	*5,5*	*8,5*	*8,5*	*7,0*	*5,5*	*9,0*	*10,0*	*7,0*	*7,5*	4,5	*9,0*	6,5	*7.2*	*7,0*	—	—	*4,5*	*5,0*
b_1	*5,0*	*6,0*	5,5		—	*4,5*	*3,0*	*5,0*	*6,5*	*7,0*	*6,5*	*5,5*	*6,0*	*8,0*	*6,0*	*8,0*	4,0	*8,0*	6,0	*6,5*	*5,0*	*6,0*	—	*5,0*	*5,0*
b_2	1,7	*3,7*	3,5	*7,0*	*3,0*	3,3	*2,0*	2,5	*5,3*	*5,3*	4,3	5,0	*3,0*	4,0	4,0	5.0	2,7	7,0	4,3	4,5	2.7	*4,5*	2,6	3,0	2,4
H	—	*3,0*	2,5	—	—	*2,5*	*1,5*	2,5	3,7	4,0	3,0	4,5	3,0	3,5	2,5	4,0	2,0	3,5	3,0	2,7	2,0	3,0	1,7	2,5	1,8
α	58°	*65°*	60°	—	—	*65°*	—	*60°*	*60°*	—	65°	58°	55°	*48°*	72°	78°	65°	77°	*62°*	71°	77°	—	—	72°	60°
×	120°	90°	96°	—	—	90°	95°	100°	97°	*90°*	90°	120°	120°	125°	92°	93°	112°	95°	110°	95°	100°	*100°*	100°	100°	112°
a/s	*0,82*	*0,90*	0,90	—	—	*1,17*	*0.67*	*0,90*	*1,05*	*0,90*	*1.17*	*0,81*	*0,88*	*0,80*	*0,71*	*0,89*	0,88	*1,00*	0,95	*0,87*	*0,85*	—	—	*1,00*	*0,90*
B/L	*0,71*	*0,75*	0,91	—	—	*0,71*	*0,75*	*0,90*	*0,65*	*0,72*	*0,78*	*0,50*	*0,54*	*0,72*	*0,92*	*0,86*	0,80	*0,72*	0,78	*0,81*	*0,83*	*0,75*	—	*0,90*	*0.94*
H/B	—	*0,50*	0,45	—	—	*0,55*	*0,50*	*0,50*	*0,56*	*0,57*	*0,46*	*0,81*	*0,50*	*0,43*	*0,41*	*0,50*	0,50	*0,43*	0,50	*0,41*	*0,40*	*0,50*	—	*0,50*	*0,36*
l_1/l_2	2,75	1,90	1,78	—	—	1,76	1,50	1,42	1,56	1,19	2,28	0,71	1,66	*2,00*	1,22	1,25	2,10	1,16	1,80	1,57	1,67	—	1,66	1,50	2,04
b_1/b_2	*2,94*	*1,62*	1.57	—	—	*1,36*	*1,50*	*2,00*	*1,22*	*1.32*	*1,51*	1,10	*2,00*	*2,00*	*1,50*	*1,60*	1,48	*1.14*	*1,39*	*1,44*	*1,85*	*1,33*	—	*1,66*	*2,08*

L — length of specimen; l_1 — length of anterior part as measured parallel to its surface; l_2 — length of posterior part; a — length of anterior part; s — length of anterior lateral edge; b_1 — width of anterior part; b_2 — width of posterior part; H — height of specimen; α — angle between anterior lateral edges; × — angle betwenn anterior and posterior surface

L — długość okazu; l_1 — długość części przedniej mierzona równolegle do jej powierzchni; l_2 — długość części tylnej; a — długość części przedniej; s — długość brzegu bocznego przedniego; b_1 — szerokość części przedniej; b_2 — szerokość części tylnej; H — wysokość okazu; α — kąt między brzegami bocznymi przednimi; × — kąt między przednią a tylną powierzchnią