

# 7. Brachiopoda from the Tertiary Nahuel Huapi Formation of the Patagonian Cordillera

By

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## Introduction

The material of fossils collected by LJUNGNER's Expedition from the Tertiary Nahuel Huapi Formation of the Patagonian Cordillera, now in the Palaeontological Institute of Uppsala, contains fairly numerous specimens of brachiopods, chiefly Terebratellids. Most of the specimens are preserved as partly disintegrated internal moulds, the majority of which is rather badly preserved and does not reveal sufficient internal characters to be safely determinable even as to the genus, at least at the present state of knowledge of the South American Tertiary brachiopods. By means of the new technique described in the Appendix to this paper by Mr. ERIC STÅHL we have succeeded in getting perfect impressions of the comparatively well preserved internal moulds, where the internal details may be rather satisfactorily studied. These specimens are described in the present paper. Owing to the generally poor preservation of the material safe specific determinations could not be made. At least some of the species described are apparently new but it seemed preferable at the present time to leave them without a specific name on account of the general difficulty to recognize species which are based on a scanty and badly preserved material. The following forms have been described:

### *Rhynchonellacea:*

*Tegulorhynchia* sp.

*Plicirhynchia* sp.

### *Terebratulacea:*

*Terebratella* sp.

*Pachymagas* sp.

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In addition *Tegulorhynchia imbricata* (BUCKMAN) from the Tertiary beds of Cockburn Island off Graham Land, West Antarctica, has been re-described for comparison with the above *Tegulorhynchia* sp.

In LJUNGNER's collection (loc. Bahia Lopez, "Primero de Julio") there are also numerous specimens of a Discinid (probably *Discinisca*) which, however, are rather badly preserved. This Discinid is not described in the present paper.

The geology of the Nahuel Huapi area of the Patagonian Cordillera and the general stratigraphy of the Nahuel Huapi Formation have been described by LJUNGNER (1931). According to him the Nahuel Huapi Formation is roughly contemporaneous with the Patagonian Formation in S. E. Argentina and the Navidad Formation in Chile (approximately Oligocene). The brachiopods described in the present paper are unfortunately of no great use for the correlation of the formation, partly on account of the insufficient knowledge of the Tertiary brachiopod faunas in other districts of South America. Nevertheless, the material described in the present paper is of a certain interest as it occurs in a region, where so far the brachiopod fauna has been almost entirely unknown.

The author is indebted to Professor ERIK LJUNGNER, who has placed the brachiopod material from the Nahuel Huapi Formation at his disposal and to Professor ERIK STENSIÖ of the State Museum of Natural History in Stockholm for the loan of some type specimens of BUCKMAN (1910).

#### Superfam. Rhynchonellacea SCHUCHERT, 1896

The only *Rhynchonellacea* described from Tertiary beds of South America are *Rhynchonella plicigera* IHERING, 1897 and *Rhynchonella patagonica* IHERING, 1903. Both species were transferred to their new genus *Tegulorhynchia* by CHAPMAN & CRESPIN (1923). Recently ALLAN has made *Rhynchonella patagonica* the type of the new genus *Patagorhynchia* (ALLAN 1938), and *Rhynchonella plicigera* the type of the new genus *Plicirhynchia* (ALLAN 1947). ALLAN (1947, p. 494) has on this account claimed that the genus *Tegulorhynchia* does not occur in the Tertiary beds of Patagonia. One specimen in the LJUNGNER collection from the Nahuel Huapi series, however, is determined by the present author as *Tegulorhynchia*.

From Tertiary beds (Oligocene-Miocene or preferably Miocene according to BUCKMAN 1910) of Cockburn Island, West Antarctica, BUCKMAN (1910) has described four species of Rhynchonellids placed by him in the genus *Hemithyris*, three of which have been transferred later by CHAPMAN & CRESPIN to their genus *Tegulorhynchia*, viz. *Hemithyris imbricata* BUCKMAN, 1910, *Hemithyris squamosa* HUTTON, and *Hemithyris plicigera* IHERING. The last of them has been placed by ALLAN (1947) in the genus *Plicirhynchia* ALLAN, 1947, and he also has questioned the justification of including

*Hemithyris imbricata* BUCKMAN in the genus *Tegulorhynchia*, mentioning that "the species was founded on one imperfect valve which BUCKMAN reported appears to possess no dental plates" (l. c. p. 294). This species is re-described in this paper. In the opinion of the author the specimen which BUCKMAN (1910) determined as *Hemithyris squamosa* (HUTTON) obviously is conspecific with *Tegulorhynchia imbricata* (see p. 192).

The only Rhynchonellid mentioned from the Nahuel Huapi Formation is *Rhynchonella patagonica* ORTM. (LJUNGNER 1931, p. 219). In LJUNGNER's collection (No. 5596 and 5601, Bahia Lopez, "Primero de Julio", c:a 790 m) there are some fragments of a large finely multicostellate Rhynchonellid which may belong to *Patagorhynchia patagonica* (IHERING), but owing to their poor condition they are not determinable with certainty as to the genus. From the same locality there exist, however, two other internal moulds of Rhynchonellids, which are determinable as to the genus, viz. *Tegulorhynchia* sp. and *Plicirhynchia* sp. which are described below.

#### Gen. *Tegulorhynchia* CHAPMAN & CRESPI, 1923

Genotype: *Rhynchonella squamosa* HUTTON, 1873

In Oligocene-Miocene beds this genus is, as far as yet known, confined almost entirely to Victoria, South Australia, Tasmania and New Zealand, from where about 10 species have been described. One species (*T. imbricata*) is known from West Antarctica and the specimen described below as *Tegulorhynchia* sp. from the Nahuel Huapi Formation is the only specimen described of this genus from South America.

#### *Tegulorhynchia imbricata* (BUCKMAN, 1910). Pl. I, fig. 1—4

1910. *Hemithyris imbricata* sp. n., BUCKMAN, p. 11, Pl. I, fig. 12.  
 1910. *Hemithyris squamosa* HUTTON sp., BUCKMAN, p. 10, Pl. I, fig. 13.  
 1923. *Tegulorhynchia imbricata* BUCKMAN, CHAPMAN & CRESPI, p. 184.  
 1927. (*Tegulorhynchia*) *imbricata* (BUCKMAN), THOMSON, p. 153 (name only).

1947. *Tegulorhynchia* (?) *imbricata* (BUCKMAN), ALLAN, p. 294.

Holotype (Monotype): Specimen RM Nr. Br. 1472, Pl. I, fig. 1—3.

Locus typicus: Loc. 13, Cockburn Island, off Graham Land, West-Antarctica (coll. J. G. ANDERSSON).

Stratum typicum: Glauconitic Bank [Oligocene-Miocene, or preferably Miocene, according to BUCKMAN (1910)].

Diagnosis: (Only ventral valve well known). A finely multicostellate species of *Tegulorhynchia* with 10—15 costae in the sinus, outer shell-layer strongly imbricated. The ventral sinus begins at about the middle of the

valve and deepens anteriorly rather rapidly. Outline of the valves pentagonal.

*Description.* The holotype is a ventral valve which is fairly well preserved except that the top of the beak is broken off. Not much preparation of the specimen has been carried out by BUCKMAN, as the inside of the valve was filled with an almost unconsolidated glauconite sand, which could easily be removed.

The shell is broadly pentagonal in outline, carrying a distinct, rather broad mesial sinus. The sinus does not begin until about the middle of the valve, the posterior part of which is rather uniformly convex. Anteriorly the sinus is deepening fairly rapidly, the floor of the sinus being bent down, producing a rather deeply uniplicate anterior commissure.

The multicostellate sculpture consists of relatively fine and low costae, 11—12 on the floor of the sinus. The fairly prominent growth-lines lie rather close together and at the points where they cross the costae, the outer shell-layer exhibits a comparatively strong imbrication.

Form of the beak and the foramen unknown.

The interior of the valve shows two rather thick dental plates (see pl. I, fig. 2) which rise almost vertically from the valve to the relatively stout hinge-teeth.

*Discussion.* In spite of the fact that the form of the beak, the position of the foramen and the interior of the dorsal valve of *Teg. imbricata* are unknown, it seems obvious that this species ought to be included in the genus *Tegulorhynchia*.

*Hemithyris squamosa* (HUTTON) in BUCKMAN 1910 (p. 10, pl. I, fig. 13) from the same locality and stratigraphic horizon as the holotype of *Tegulorhynchia imbricata*, is not identical with the real *Tegulorhynchia squamosa* from the Oamaruan of New Zealand, as already THOMSON (1927, p. 153) has pointed out. Unfortunately the Antarctic specimen (No. Br. 1471 of State Mus. of Nat. Hist., Stockholm) is preserved partly as an internal mould and the outer layer of the shell is missing over the entire specimen. The details of the sculpture are, therefore, indistinct; the presence of an imbrication of the outer shell-layer for instance is possible but not ascertainable. The specimen consists of a dorsal valve, the beak of which is damaged, and the anterior part of the ventral valve. It is considerably larger than the holotype of *Teg. imbricata* (see measurements).

The outline of the valve is broadly pentagonal, and the ventral sinus and the anterior commissure have the same shape as in the holotype of *Teg. imbricata*. The sculpture is in general of the same fineness as in the holotype. There seem to be about 14 costae on the floor of the sinus, but owing to the absence of the outer shell-layer no imbrication is to be seen.

In the author's opinion this specimen is conspecific with the holotype

of *Tegulorhynchia imbricata*, the apparent differences being partly due to the different state of preservation and partly to the different size of the specimens.

<i>Measurements.</i>	Length	Width
Nr. Br. 1472 (Holotype) . . . . .	ca. 11.3 mm	13.1 mm
Nr. Br. 1471 . . . . .	—	17.7 mm

*Tegulorhynchia imbricata* (BUCKMAN) is rather similar to *Tegulorhynchia depressa* (THOMSON MS 1918) ALLAN, 1937.

The latter species has been named by THOMSON (1918, p. 117) with a very brief diagnosis but was figured for the first time by ALLAN 1937 (Pl. XVI, figs. 1—2). According to the decision of the SECOND INTERNATIONAL GEOLOGICAL CONGRESS in Bologna no specific name of a fossil is valid if published after 1882 without a figure (see e.g. RICHTER, 1948, p. 153). According to this rule *Hemithyris depressa* THOMSON, 1918 must be considered a nomen nudum and the valid name for this species would consequently be *Tegulorhynchia depressa* ALLAN, 1937. The same rule is also applicable i.a. to *Hemithyris sublaevis* THOMSON, 1918, not figured before ALLAN 1931 (Pl. 20, fig. 4) and *Hemithyris antipoda* THOMSON, 1918, not figured before ALLAN 1937 (Pl. XVI, fig. 3).

*Tegulorhynchia depressa* seems to have a somewhat coarser sculpture than *Teg. imbricata* (9 costae in the sinus according to ALLAN 1937, p. 124, against 11—14 in *Teg. imbricata*) and there seem also to exist some differences in the shape of the ventral sinus. The outline of the valves of *Teg. depressa* seems to be more rounded than that in *Teg. imbricata*, which has a pentagonal outline.

#### *Tegulorhynchia* sp. Pl. I, fig. 5—7

*Material.* One internal mould of both valves, LJUNGNER's collection Nr. 5489, Bahia Lopez, "Primero de Julio", ca. 790 m.

*Description.* The specimen is laterally compressed and the ventral valve somewhat damaged. One cannot, therefore, be quite sure as to the exact outline of the valves.

The dorsal valve seems to be considerably more convex than the ventral one. The ventral sinus is quite deep, obviously reaching posteriorly almost to the beak of the valve, the anterior commissure deeply uniplicate (Pl. I, fig. 6).

The sculpture is rather badly preserved. In the sinus there are traces of 10—12 costae, reaching posteriorly as far as the sinus.

The interior of both valves shows the usual *Tegulorhynchia* character. In the ventral valve there are two rather thick dental plates which support the fairly stout hinge-teeth. In the dorsal valve (Pl. I, fig. 7) the cardinal process is confined to a small and narrow platform at the roots of the

crural bases and is indistinct in this specimen. The crural bases diverge rather strongly anteriorly, the posterior ends of the crural plates curving in a ventral direction. The hinge-ridge is low, borders the crural bases laterally. On the floor of the valve there is a thin and relatively low septum which reaches anteriorly to about the middle of the valve and posteriorly up to the cardinal process.

*Measurements.* Length: ca. 19 mm. Width ca. 17 mm?

*Discussion.* The above specimen obviously is referable to the genus *Tegulorhynchia*. It is fairly similar to the genotype, *Tegulorhynchia squamosa* (HUTTON) (see e.g. CHAPMAN & CRESPIAN 1923, pl. XI, figs. 1—2 and THOMSON 1927, pl. II, figs. 3—10) and *Teg. imbricata* (BUCKMAN), both of which possess a similar type of finely multicostellate sculpture. A closer comparison, however, is hardly possible on account of the imperfect state of preservation of the specimen described. Unfortunately, the dorsal interior of *Teg. imbricata* is unknown and that of *Teg. squamosa* imperfectly described and not figured.

#### Gen. *Plicirhynchia* ALLAN, 1947

Genotype: *Rhynchonella plicigera* IHERING, 1897

Up to now the genotype of *Plicirhynchia* was the only species assigned to the genus. It occurs in the Patagonian Formation of Patagonia, and one specimen had been found by J. G. ANDERSSON at loc. 13, Glauconite Bank, Cockburn Island off Graham Land, West Antarctica (BUCKMAN 1910 p. 12, pl. I, fig. 10). It seems, however, possible that also *Hemithyris dibbleei* HERTLEIN & GRANT, 1944 (Eocene of California) and *Hemithyris reaganii* HERTLEIN & GRANT, 1944 (Oligocene of Washington) should be placed in this genus. In the general type of sculpture these species (see HERTLEIN & GRANT 1944) are very similar to *Plicirhynchia*. However, their interior being unknown, the generic reference is uncertain. At any rate they are not typical *Hemithyris*. In addition there exists in LJUNGNER's collection one internal mould which shows traces of sculpture of the *Plicirhynchia*-type but which is obviously not conspecific with the genotype.

#### *Plicirhynchia* sp. Pl. I, fig. 8—9

*Material.* One somewhat compressed internal mould of both valves, LJUNGNER's collection Nr. 5491, Bahia Lopez, "Primero de Julio", ca. 790 m.

*Description.* The whole specimen is relatively weakly convex, especially in comparison with the last specimen described. The ventral sinus is rather low and shows impressions of 7—8 coarse costae, which reach posteriorly to about the middle of the valve. The posterior parts of both valves are without traces of sculpture. The sculpture of this specimen obviously is of the *Plicirhynchia*-type, with rather broad and low costae on the anterior

part of the valves only, but it is possible, though not probable that owing to a thick shell, the costae on the posterior part of the valves have left no impression in the internal mould.

Inside the ventral valve the dental plates are relatively thin. In the dorsal valve the cardinal process is of about the same shape as in *Tegulorhynchia* sp., but a little larger and more protruding. It is confined to the posterior end of the crural bases, where it forms a small, elevated platform. The crural bases are strongly diverging anteriorly, the hinge-ridges very low and weak. The dorsal septum is weak and low, scarcely visible, and anteriorly it does not reach the middle of the valve.

*Measurement.* Length: ca. 19 mm.

*Discussion.* The general convexity of the valves and the visible impressions of the paucicostate sculpture on the internal mould suggest that this specimen belongs to the genus *Plicirhynchia*. The dorsal interior of *Plicirhynchia* is of the general *Tegulorhynchia*-type and no diagnostic differences were reported by ALLAN (1947). The specimen described is hardly conspecific with the genotype, since it has more numerous and obviously coarser costae in the ventral sinus.

#### Superfam. Terebratulacea WAAGEN, 1883

The material of Terebratulids in LJUNGNER's collection consists chiefly of internal moulds but there are also some complete specimens, the surface of which, especially that of the area around the beak is generally not well preserved. By means of the dibutylphthalate-polyvinylchloride-method (see p. 201) we have obtained perfect impressions of relatively well preserved internal moulds, on which the details of the internal structure can be studied. These specimens are with certainty determinable as to the genus. Owing to the rather imperfect knowledge of the internal structure of South American Tertiary Terebratulids, especially of those which have been described from Chile by PHILIPPI (1887), and with regard to the difficulty in comparing the specimens represented by internal moulds only with specimens, of which the exterior only is known, it is hardly possible at present to make safe specific determinations.

#### *Terebratella* sp. Pl. II, fig. 1—2

*Material.* One internal mould of the dorsal valve and of the beak of the ventral valve, LJUNGNER's collection Nr. 5616, Cerro Lopez, the slope towards Lago Moreno Oeste.

*Description.* It is a rather large specimen (with a length of about 37 mm and a width of about 37 mm). It has apparently a smooth surface, only two or three growth lines being visible on the internal mould. The anterior commissure seems to be rectimarginate or slightly sulcate.

In the interior of the ventral valve, there are no traces of dental plates, the rather stout hinge-teeth being unsupported. The foramen seems to be rather large, but its exact position is not determinable.

In the interior of the dorsal valve the high and comparatively thick septum reaches anteriorly a little beyond the middle of the valve. The thin, excavate hinge-plates unite with the septum. A little behind the middle of the valve two fragile plates are found attached to the upper part of the septum. These plates obviously are remnants of a brachidium of the *Terebratella*-type. The cardinal process is transversely almond-shaped, forming a small raised platform below the beak of the valve and being partly supported by the hinge-plates. There is no real boundary between the crural bases and the hinge-plates, the ventral surface of the latter continuing into the surface of the crural bases. The crural plates are broken off.

*Discussion.* The small plates attached to the septum a little behind the middle of the dorsal valve suggest a brachidium of the *Terebratella*-type. A closer determination of the specimen is, however, scarcely possible at the present time.

#### *Pachymagas* sp. Pl. II, fig. 3—7

*Material.* Three internal moulds, LJUNGNER's collection Nrs. 5143, 5146, 5150, Lago Moreno Oeste, easternmost peninsula of the peninsula San Pedro. Further, there exist from the same locality two complete specimens, which show the exterior only (Nrs. 5141, 5148). Very likely these specimens belong to the same species as the internal moulds.

*Description.* The margins of the valves of the internal moulds are partly broken off, and the outline of these specimens is therefore not fully known. The anterior commissure seems to be nearly rectimarginate or very slightly sulcate.

No traces of dental plates can be seen in the interior of the ventral valve. Hinge-teeth are fairly strong, supported by the swollen bases only.

As to the dorsal valve (pl. II, fig. 7) the cardinalia is comparatively strong. The septum is high and rather thick, reaching anteriorly to about a third of the length of the valve. Posteriorly the septum bifurcates rather broadly and joins the anterior ends of the crural bases, which posteriorly are fused with the socket-ridges. The cardinal process is rather large, reaching about as high as the socket-ridges and being completely separated from them.

The complete specimens from the same locality (pl. II, fig. 3—6) have a smooth surface, subcircular or slightly ovate outline, rectimarginate or slightly sulcate anterior commissure, moderate, suberect beak and a large apparently mesothyrid foramen. Deltidial plates are not distinguishable on account of the bad state of preservation.



*Measurements.*

	Length	Width
Nr. 5143 . . . . .	—	ca. 28 mm
Nr. 5146 . . . . .	ca. 30 mm	—
Nr. 5148 . . . . .	27.5 mm	27 mm
Nr. 5141 . . . . .	—	24.5 mm

*Discussion.* In its internal characters this species does not agree with any species of *Pachymagas* previously described from South America (IHERING 1903). Compared with the other South American *Pachymagas*-species the specimens described differ in having an isolated much smaller cardinal process, slenderer socket-ridges and apparently a thinner and comparatively higher septum. In these respects the above species is similar to the Hutchinsonian (Upper Miocene) species from New Zealand, such as *Pachymagas parki* HUTTON (see THOMSON 1927, p. 89). The species described is apparently new, but owing to the bad state of preservation it must be left unnamed.

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### Explanation of plates

RM = State Museum of Natural History, Palaeozoological Dep., Stockholm.

UM = Museum of the Palaeontological Institute of the University of Uppsala.

All specimens on plates I and II whitened by means of ammonium chloride. N. HJORTH and V. JAANUSSON phot., ERIC STÅHL ret.

#### Plate I

- 1—3. *Tegulorhynchia imbricata* (BUCKMAN). RM No. Br. 1472. Holotype. West-Antarctica, Cockburn Island off Craham Land, Loc. 13, Glauconitic Bank. Coll. J. G. ANDERSSON. × 3. Fig. 1 ventral view, fig. 2 ventral interior, fig. 3 anterior view.
4. *Tegulorhynchia imbricata* (BUCKMAN). RM No. Br. 1471. The same locality and horizon as the holotype. The specimen was figured by BUCKMAN (1910, Pl. 1, fig. 13) as *Hemithyris squamosa* (HUTTON). Coll. J. G. ANDERSSON. × 3. Dorsal valve. The outer shell-layer is missing.
- 5—7. *Tegulorhynchia* sp. UM (LJUNGNER's collection) No. 5489. Nahuel Huapi Area, Patagonia, Bahia Lopez, Nahuel Huapi Formation. × 2. Fig. 5 internal mould of the dorsal valve, fig. 6 anterior view of the internal mould, fig. 7 interior of the dorsal valve, impression made by the dibutylphthalate-polyvinylchloride method.
- 8—9. *Plicirhynchia* sp. UM (LJUNGNER's collection) No. 5491. Nahuel Huapi Area, Patagonia, Bahia Lopez, Nahuel Huapi Formation. × 2. Fig. 8 internal mould of the dorsal valve, fig. 9 interior of the dorsal valve, impression made by the dibutylphthalate-polyvinylchloride method.

#### Plate II

- 1—2. *Terebratella* sp. UM (LJUNGNER's collection) No. 5616. Nahuel Huapi Area, Patagonia. Cerro Lopez, the slope towards Lago Moreno Oeste, Nahuel Huapi Formation. × 1. Fig. 1 internal mould of the dorsal valve, fig. 2 interior of the dorsal valve, impression made by the dibutylphthalate-polyvinylchloride method.
- 3—6. *Pachymagas* sp. UM (LJUNGNER's collection) No. 5148. Nahuel Huapi Area, Patagonia. Lago Moreno Oeste, easternmost peninsula of the peninsula San Pedro, Nahuel Huapi Formation. × 1. Fig. 3 dorsal view, fig. 4 ventral view, fig. 5 lateral view, fig. 6 anterior view.
7. *Pachymagas* sp. UM (LJUNGNER's collection) No. 5143. The same locality as fig. 3—6. × 2. Interior of the dorsal valve, impression made by the dibutylphthalate-polyvinylchloride method.

## Appendix:

# A new casting-method for palaeontological purposes

By

**Eric Ståhl**

**Introduction:** To produce satisfactory impressions of fossils, especially of small internal moulds, has often proved difficult and sometimes even impossible. In order to obtain good results the author has worked out a new method, the dibutylphthalate-polyvinylchloride-method, the description of which is given below.

The dibutylphthalate-polyvinylchloride-method has the following features:

1. In fluid condition the casting material possesses a relatively low viscosity, so that the liquid can easily penetrate into rather small and narrow cavities.

2. The impression is elastic, and can be easily removed from the mould and without breaking be withdrawn also from narrow cavities and undercut parts. This property is of great value, particularly with regard to internal moulds of brachiopods, the cavities (e.g. of crural plates) of which generally project more or less deeply into the internal mould.

3. The impression is unshrinkable.

4. The surface of the impression exhibits such minute details that it may be studied satisfactorily also under magnification.

5. The impression is tough and, as far as can be judged from our experiences, suffers no change during a long space of time.

6. No solvent which has been tried by us has been found to act upon the compound.

7. The outer layer of the impression is partly transparent. It is therefore appropriate to apply a thin coat of ammonium chloride in order to produce an opaque surface when studying it and taking photographs.

**Description of the method:** The following material is required:

Plaster (alabaster-, dental-)

dibutylphthalate (soaphthal B can also be used)

fine-ground polyvinylchloride

plasticine or clay.

Pl. III, Fig. 1 shows an internal mould of which an impression will be made.

A roll of clay or plasticine of about the length of the circumference of the internal mould or fossil is formed and rolled out to a ribbon about 20 mm broad and 3 mm thick. The edges are cut straight and cleaned with a knife. The ribbon is then mounted like a wall around the fossil. Observe that the ribbon must fit closely to the stone, and this is accomplished when by the careful use of a fine knife its outside is made as even and smooth as possible. Pl. III, Fig. 2 shows the mounted ribbon.

Water of about the same volume as the 3 mm thick mounted clay ribbon is poured into a bowl of rubber or china and as much well loosened plaster as can be absorbed is strewn by hand without stirring into the water, or one proceeds until small spots of dry plaster are forming upon the surface. After about 20 seconds the compound is stirred with a spatula in order to mix the plaster with the water as homogeneously as possible. A 2—3 mm thick layer of plaster is now with a spatula applied to the outside of the clay ribbon and like the latter closely attached to the stone. The layer or coat of plaster must not be too thick as it will have to be removed later on.

Pl. III, Fig. 3 shows how the coat ought to look. The clay ribbon is now carefully removed with a thin knife so as not to damage or detach the coat of plaster (Pl. III, Fig. 4). If small clay or plasticine particles should adhere to the specimen they can be removed without damaging it with a pointed piece of clay or plasticine which is carefully pressed against particles until they cling to it.

The stone with the adhering coat of plaster has now to be immersed into water and left there till it is thoroughly saturated whereupon it is taken up and all superfluous water blown off, so that the stone and the plaster show an evenly damp surface.

About the same quantity of dibutylphthalate as the bowl formed by the coat can hold is poured into a jar of glass or china. Under constant stirring fine-ground, well loosened polyvinylchloride is strewn into the dibutylphthalate till the compound shows a white, smooth, creamy consistence. At this stage it is now ready to be poured into the bowl formed by the coat. Let the compound flow slowly down the inner side of the coat and spread evenly upon the moist fossil avoiding the formation of air-bubbles. In order to prevent air-bubbles in narrow deep cavities, the latter can advantageously be filled with the compound by means of a sliver of wood or a hair from a brush. When the whole surface is covered more compound up to 2 cm thickness is poured on (Pl. III, Fig. 5).

The internal mould with the filled coat of plaster is now placed in an oven heated to 120° C where it usually is left 2—2½ hours at constant temperature. The compound then turns into a rubber-like elastic mass. It becomes harder during the continuous heating which, however, must not extend beyond 5 hours as otherwise the compound may shrink. The

whole specimen is then immersed in cold water to cool. Afterwards the coat of plaster is broken with a hammer and the elastic cast removed (Pl. III, Fig. 6). If there are strongly projecting parts or cavities where the cast adheres to the stone it is best to put the specimen back into water and try to remove the cast by carefully lifting the projecting portions of the impression so that the water can penetrate between the mass and the stone.

The elastic cast, the outer layer of which is partly transparent, should now in the ordinary way be treated with the ammonium chloride in order to obtain an evenly white surface. After whitening the cast is now ready for examination and photography (Pl. II, Fig. 2).

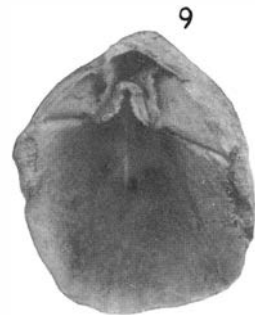
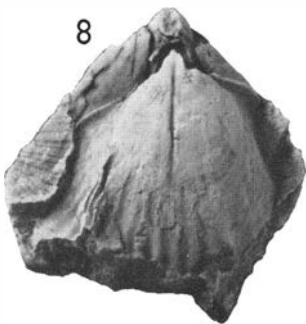
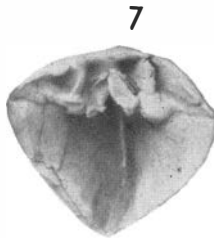
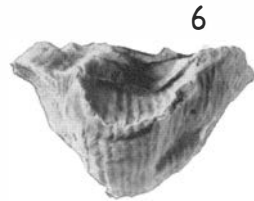
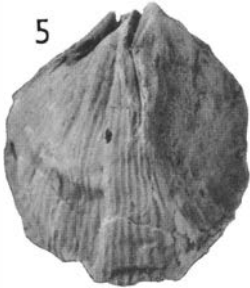
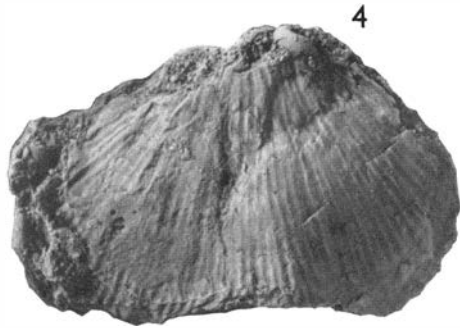
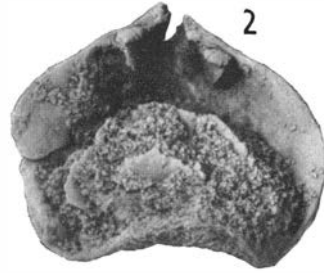
Should plaster casts of the elastic cast be required it is, of course, not necessary to whiten it. When removed from the stone it is first covered with a thin layer of plaster. On pouring the plaster the cast is knocked against the table so that the plaster can penetrate into every cavity and accidental air-bubbles may loosen. More plaster is poured on up to the required thickness. For plaster casting the plaster is mixed in the same way as described above.

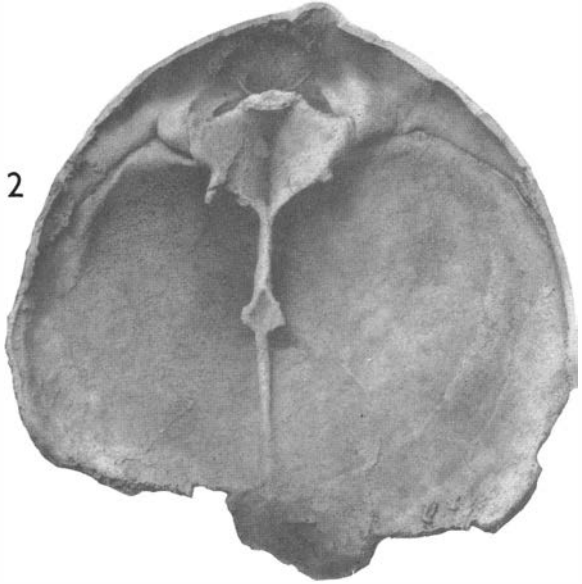
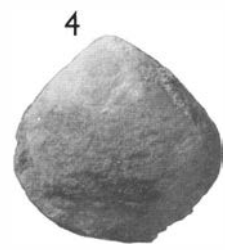
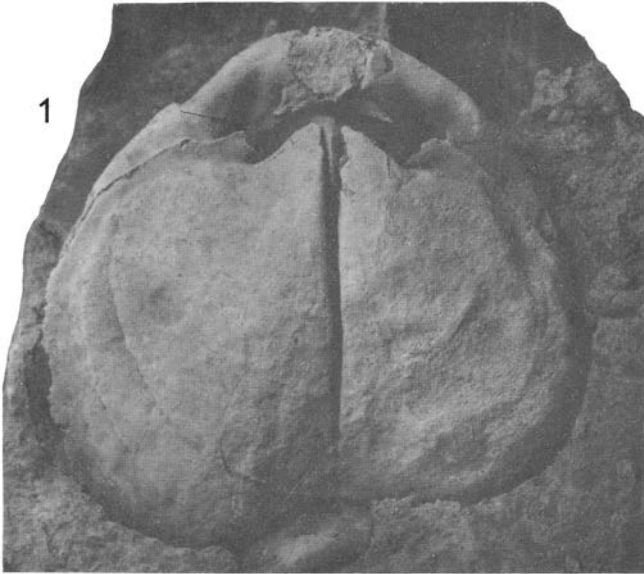
In order to obtain a plaster impression identical with the elastic one made directly from the fossil, first a 3 mm thick plaster cast of the elastic impression is made. This cast is then dipped for about one minute into a solution of one part of potash to 25 parts of water. When the surface of the plaster is damp but free from aggregations of water more plaster up to the required thickness is poured over the cast treated with the solution. And finally the first, thin plaster is carefully removed with small chisels so as not to damage the plaster impression.

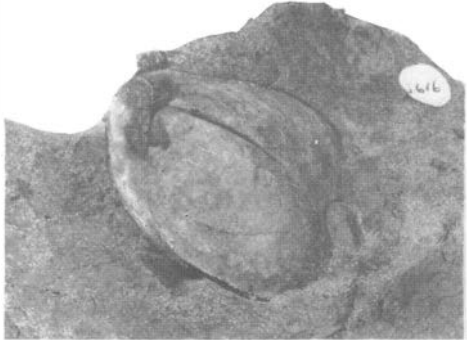
### Plate III

The plate illustrates the dibutylphthalate-polyvinylchloride-method. The internal mould belongs to *Terebratella* sp. UM (LJUNGNER's collection) No. 5616 (see also Pl. II, fig. 1—2).  
×1. N. HJORTH phot., unretouched.

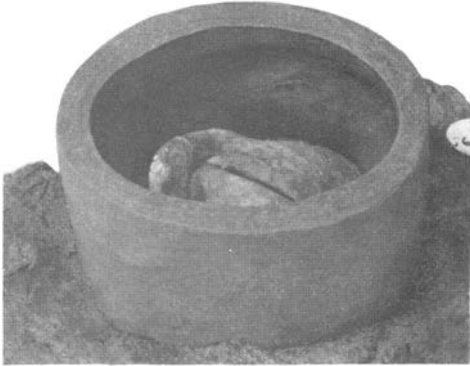
1. The internal mould of which the impression is to be made.
2. The plasticine ribbon has been mounted around the internal mould.
3. The plaster coat has been built around the plasticine ribbon.
4. The plasticine ribbon has been removed, the plaster coat is left standing around the internal mould.
5. The plaster coat has been filled with the dibutylphthalate-polyvinylchloride compound.
6. After heating the plaster coat has been removed.



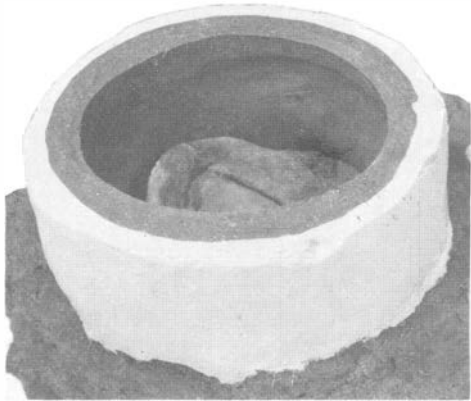




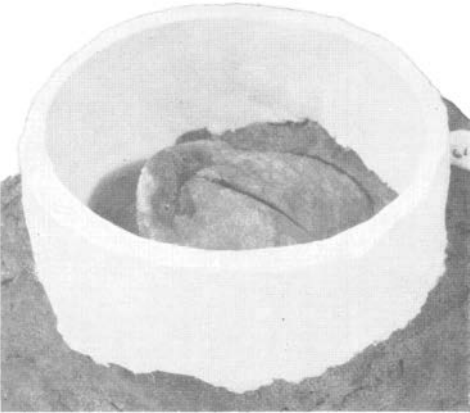
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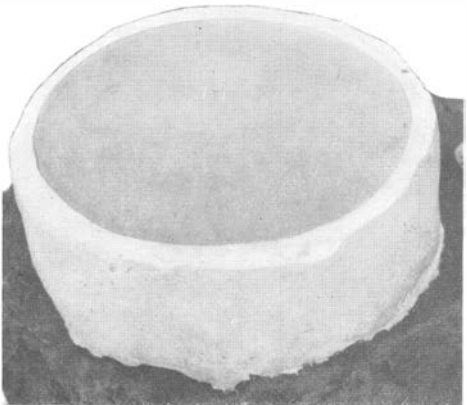
2



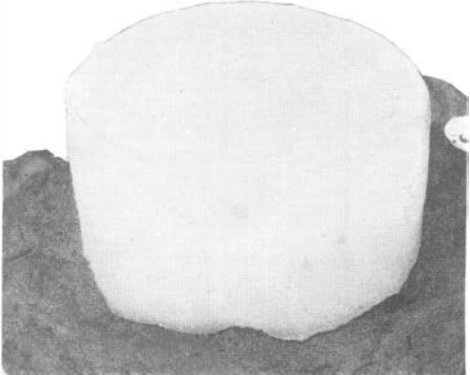
3



4



5



6