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PRELIMINARY NOTE
ON THE RANGE OF PTERASPIDS IN WESTERN EUROPE,

by ERROL IVOR WHITE (London).

The importance of Pteraspids in Lower Devonian stratigraphy can hardly be overestimated, for by reason of their wide geographical range and apparently brief specific duration, they seem to offer a sound means of dividing and correlating the troublesome continental and sub-continental strata.

A few years ago I made an attempt to zone the lower Old Red Sandstone of the Anglo-Welsh border by means of the known ostracoderms (1). Three of the zones were based on species of *Pteraspis*: the base of the Dittonian was in many areas characterized by the small, snub-nosed species *P. leathensis* WHITE. The main mass of the fossiliferous Dittonian strata yielded the two most familiar species, *P. crouchi* LANK. with a long narrow snout, and *P. rostrata* (AG.) with a more triangular snout, both of medium size (2). The upper part of the Dittonian in this area is predominantly marly and usually unfossiliferous. The Senni Beds at the base of the succeeding Breconian group yielded remains of *P. (Rhinopterapsis) dunensis* (ROEMER) (3), the large blade-snouted form that ranges through the Upper Siegenian to the Middle Emsian in Germany (4). Later the gap between the « *crouchi-rostrata* » zone and the « *dunensis* » beds of the Breconian was at least partly filled by the

(1) E. I. WHITE, *The Vertebrate Faunas of the Lower Old Red Sandstone of the Welsh Borders*. Bull. Brit. Mus. (Nat. Hist.), Geology, vol. 1, 1950, pp. 52-58.

(2) See footnote (27) p. 6.

(3) E. I. WHITE, *New Pteraspids from South Wales*. Quart. Journ. Geol. Soc. London, vol. 94, 1938, p. 110.

(4) W. GROSS, *Die unterdevonischen Fische und Gigantostraken von Overath*. Abhand. preuss. geol. Gesell., (N.F.), Heft 145, 1933, p. 52. — H. LIPPERT, *Unterkoblentz-Fundpunkte im Norden und Westen der Sötenicher Mulde*. Senckenbergiana, vol. 19, 1937, pp. 282-8.

important discovery by Drs. BALL and DINELEY of an extensive fauna with *P. (Rhinopteraspis) leachi* WHITE (5) in the upper Dittonian of the Cleve district (6).

P. leathensis has its counterpart in France in *P. (Protopteraspis) gosseleti* LERICHE (7), a closely related species from the « Psammites de Liévin » in the Pas-de-Calais.

Either or both *P. crouchi* and *P. rostrata* occur in appropriate beds of upper Gedinian age in the Pas-de-Calais (Grès de Pernes) (8), Belgium (Psammites de Fooz) (9) and Germany (10). Thus far there is no disharmony between the English and Continental faunas, but two apparently anomalous cases must be mentioned. In the first, P. DOLLÉ (11) records from shaft No. 8 at Liévin *P. dunensis* in association with *P. crouchi* and *P. rostrata*. In fact all the specimens figured, so far as they may be specifically identified, belong to *P. crouchi*, like all those from shaft No. 6 described by Leriche (12).

In the second case, *P. rostrata* was recorded from the Grès de Vimy with specimens originally identified as *P. dewalquei* and subsequently referred to *P. dunensis*. Still later these were ascribed to *P. rostrata* (13), but those examined belong to a new species.

It was apparently by reason of the identification of these specimens as *P. dewalquei*, in company with accepted specimens of *P. rostrata*, that the Grès bigarré de Vimy was correlated with the Schistes de St. Hubert and both with the « *crouchi-rostrata* » beds of the Anglo-Welsh Dittonian (14).

The Belgian records of *P. (Rhinopteraspis) dunensis* present a number of important problems. E. ASSELBERGHS, in his paper on the vertical

(5) This species was originally described (E. I. WHITE, 1938, *loc. cit.*, p. 87) as a variety of *P. (R.) dunensis*, but subsequent discoveries have shewn that it is specifically distinct. At first it was thought that the strata in which it was first found at Swanlake Bay were in the lower part of the Dittonian, but subsequent work in the field by Mr. H. A. TOOMBS has shewn that the area is so faulted that the structural evidence is negative, and the only evidence is given by the fossils themselves.

(6) H. W. BALL & D. DINELEY, *Notes on the Old Red Sandstone of the Cleve Hills*. Proc. Geol. Assoc. London, vol. 63, 1952, p. 213.

(7) M. LERICHE, *Contributions à l'étude des Poissons fossiles du Nord de la France*, etc. Mém. Soc. géol. Nord, t. 5, 1906, p. 26.

(8) M. LERICHE, *loc. cit.*, 1906, pp. 27, 32.

(9) M. LERICHE, *Les Pteraspis du Dévonien de la Belgique*. Bull. Soc. belge Géol., t. XXXIII (1923), p. 147.

(10) W. SCHMIDT, *Die ersten Vertebraten-Faunen im deutschen Gedinne*. Palaontographica, Band 105, Abt. A, p. 1.

(11) P. DOLLÉ, *Poissons dévoniens trouvés au cours du forçage du puits 8 du Groupe de Liévin*. Ann. Soc. géol. Nord, t. 70, 1950, pp. 185-204.

(12) M. LERICHE, *Le Pteraspis de Liévin*. Ann. Soc. géol. Nord, t. XXXII, 1903, p. 161.

(13) E. ASSELBERGHS, *Sur l'extension verticale de Pt. dunensis en Ardenne*. Ann. Soc. géol. Belg., t. LXVI, 1942, p. B37. — M. LERICHE, *Sur la Faune du Grès de Wihéries*. Bull. Soc. belge Géol., t. LVI, 1948, p. 295.

(14) J. GOSSELET, C. BARROIS, et al. *Description de la Faune Siluro-dévonienne de Liévin*. Mém. Soc. géol. Nord, t. VI, fasc. 2, 1920, pp. 165, 170, tabl. XI. — T. S. WESTOLL, *The Vertebrate-bearing Strata of Scotland*. 18th Internat. Geol. Congress (London), pt. XI, 1951, p. 12, tabl. III.

distribution of this species (15) gives the stratigraphical range as Upper Gedinnian to Upper Siegenian, which, if true, obviously very much diminishes the value of the species for correlation purposes. But it is certain that there has been confusion between three, if not more, species of large size, and large size seems often to have been a dominant factor in the identification of specimens as *P. dunensis*.

Two Upper Gedinnian records of *P. dunensis* are given by M. ASSELBERGHS, Villance (Assise d'Oignies) and Carlsbourg (Assise de St-Hubert), and recently he has added a third, Paliseul (16). It may be said at once that the specimens from Villance, as figured by LERICHE (17), which are internal casts of ventral disks poorly preserved, shew no character peculiar to *P. dunensis* and could belong to *P. rostrata*, of which even larger specimens are known from England (*P.r. monmouthensis*), (18) or to a new species.

The second record, that of Carlsbourg, is based on a single specimen consisting largely of the internal cast of the whole dorsal armour with all but the base of the rostrum broken away. This was described as the type of a new species, *P. dewalquei* FRAIPONT, but was later referred to *P. dunensis* by LERICHE (19). Thanks to the courtesy of M^{me} CARPENTIER-LEJEUNE I have been able not only to examine this important specimen, but further to develop it; it undoubtedly represents a distinct species, of which the outstanding characters are given below (p.).

The Paliseul specimens are also from the assise de Saint-Hubert. Through the kindness of Professor ASSELBERGHS I have been able to examine the principal specimens, from quarries 1,5 and 7, and all are typical examples of *P. (Rhinopteraspis) leachi*, the characteristic species of the Lower Siegenian strata at Wihéries, Nonceveux and probably also Rossart (see below).

None of the Upper Gedinnian records of *P. dunensis* are therefore correct.

Of equal interest are the Lower Siegenian (S1) records of M. ASSELBERGHS (20). Through the courtesy of Dr. E. LELOUP of Brussels, Professor MARLIÈRE of Mons and Professor UBAGHS of Liège, I have had the opportunity of examining many of the specimens on which these records are based.

GISEMENT DE ROSSART. — DUPONT's specimen from the Bois d'Austrouge, « 500 mètres au S.-O. de la halte de Prê-du-Bois » is a large fragment of a dorsal shield, which from the fineness of the ornamen-

(15) E. ASSELBERGHS, *loc. cit.*, 1942, p. B36.

(16) E. ASSELBERGHS, *Découverte de Pteraspis dunensis dans le Gedinnien supérieur de Paliseul*. Bull. Acad. roy. Belgique (Classe Sci.), 5^e série, t. XLI, p. 937.

(17) M. LERICHE, *loc. cit.*, 1906, p. 34, pl. III.

(18) E. I. WHITE, *The Ostracoderm Pteraspis Kner*, etc. Phil. Trans. Roy. Soc. London, Ser. B, vol. 225, 1935, p. 448. The exact age of the beds from which this form comes is uncertain, but it seems likely to be rather late Dittonian.

(19) M. LERICHE, *loc. cit.*, 1924, p. 155.

(20) E. ASSELBERGHS, *loc. cit.*, 1942, p. B36; also *L'Eodévonien de l'Ardenne et des Régions voisines*. Mém. Inst. géol. Univ. Louvain, t. XIV, pp. 114, 118, etc.

tation (70 ridges per mm) does certainly not belong to *R. dunensis*. It is probably *R. leachi*.

GISEMENT DE MENDE St-ETIENNE. — A flattened ventral disc, probably of *Protaspis*.

GISEMENT DE NONCEVEUX. — All the specimens that I have seen belong to either *R. leachi* or to *Protaspis* sp.

GISEMENT DE BEN-AHIN. — I have not seen the specimen mentioned by LERICHE (21), but the only reason given for attributing this disk to *R. dunensis* is its large size, which of course applies equally to *R. leachi*, *P. dewalquei* and to *P. rostrata monmouthensis*.

GISEMENT DE WIHÉRIES. — The numerous specimens from this locality have been well described and figured by LERICHE (22). That there are two fossiliferous horizons 30 metres apart (LERICHE, 1925, p. 76; 1948, p. 283) has not received sufficient emphasis. All the figured specimens, except one, are from the older horizon, and all of these that are specifically identifiable belong either to *Protaspis*, being very broad with a short rostrum (e.g., 1925, text-fig. 4; 1926, pl. II), or to *R. leachi* (e.g., 1925, pls. II-IV). *R. dunensis* is absent. On the other hand, the only specimen from the higher level is a typical ventral disk of *R. dunensis*, the only correct record of this species so far from Belgium. It is between these two levels at Wihéries that the *leachi* fauna is replaced by that of the true *dunensis*, and here perhaps we may put the boundary between the Lower and Middle Siegenian.

The *leachi* and *dunensis* faunas are also found in the Dartmouth Slates from the same area in south Cornwall, S.W. England, but here the stratigraphy is so confused and the collecting has been so inexact that it is not yet possible to fix their precise relationships — indeed, these two species and a *Protaspis* together form the so-called « *Pteraspis cornubica* ». It seems, however, that both the Lower and Middle Siegenian are represented in this area.

A new record of *R. dunensis* for Belgium is based on a typical rostrum from near Pepinster, kindly sent to me by Professor UBAGHS. The exact locality is given by Professor UBAGHS (*in lit.*, 19-I-1955) as « sur l'escarpement de la rive gauche de la Vesdre, en aval d'Ensival, entre les lieux dits : Fontaine de la Gougie et Fontaine aux Cressons. Géométriquement, le fossile a été trouvé 4 m au-dessus du Poudingue de Burnot (sommet de l'Emsien), mais, comme les couches sont renversées, c'est donc stratigraphiquement à 4 m en-dessous qu'il a été recueilli. Enfin, il se peut qu'une faille intervienne entre le gisement proprement dit et le Poudingue de Burnot, faille qui aurait eu pour effet de supprimer une partie importante du Dévonien inférieur ».

(21) M. LERICHE, *loc. cit.*, 1924, p. 146 (1).

(22) M. LERICHE. Bull. Soc. belge Geol., t. XXVI, 1912, p. 49; *idem.*, t. XXXIII, 1924, p. 143; *idem.*, t. XXXIV, 1925, p. 75; *idem.*, t. XXXV, 1926, p. 19; *idem.*, t. LVI, 1948, p. 280.

I have not examined any of the specimens from the Middle or Upper Siegenian quoted by Professor ASSELBERGHS, but one may expect them to be correctly identified.

Now that it has been found possible to separate the four species hitherto grouped under *R. dunensis*-*P. rostrata*, *P. (?R.) dewalquei*, *P. (R.) leachi*, and *P. (R.) dunensis* proper, the following correlation between the British and Continental Lower Devonian is suggested.

	Anglo-Welsh Basin	N. France & Belgium	S.W. Germany	
BRECONIAN	Senni Beds	?	<i>dunensis</i> (Klerfer Schichten)	MIDDLE EMSIAN
		↑	<i>dunensis</i> (23)	LOWER EMSIAN
		<i>dunensis</i> (Pepinster, ?St.-VITH)	<i>dunensis</i> (23)	UPPER SIEGIAN
DITTONIAN	<i>dunensis</i> (Primrose Hill)	<i>dunensis</i> (Wihéries, upper)		MIDDLE SIEGIAN
	<i>leachi</i> (Swanlake, Clee)	<i>leachi</i> (Wihéries, lower) (Nonceveux, ?Rossart) (Paliseul)		LOWER SIEGIAN
	<i>rostrata</i> & var. <i>monmouthensis</i> ? (Monmouthshire)	<i>rostrata</i> & sp. nov. (Vimy, ?Villance)		UPPER GEDINNIAN
	<i>crouchi</i> & <i>rostrata</i> (widespread)	<i>crouchi</i> &/or <i>rostrata</i> (Quiévreachain, Liévin, Pernes, Ombret-Neuville, Vitrival)	<i>crouchi</i> & <i>rostrata</i> (Hohe Venn) (24)	
	<i>leathensis</i> (widespread)	<i>gosseleti</i> (Liévin)		LOWER GEDINNIAN
DOWNTONIAN				

(23) W. GROSS, *loc. cit.*, 1933, p. 42.

(24) W. SCHMIDT, *Die ersten Vertebraten-fauna im deutschen Gedinne*. Palaeontographica, Band 105, Abt. A, 1954, pp. 1-47.

The above scheme is purely tentative and there may be overlapping in the specific ranges, but it does shew the probability that the Dittonian of the Anglo-Welsh Region ranges from the upper part of the Lower Gedinnian to the Lower Siegenian.

* * *

It is not appropriate here to describe or even define the various species of *Pteraspis* mentioned in this communication, but their more obvious features may be noted. It may be said once again that size is no criterion; even the huge specimens of *R. dunensis* from the Dartmouth Slates, which reached a total length of 1.5 metres, had young nearly as small as the little *P. gosseleti* or *P. leathensis*, while the customary reference of all large plates to *R. dunensis* (25) has been the source of much confusion. However, species do have a maximum size and large plates cannot belong to small species. It is very often impossible to identify for certain imperfect isolated plates, especially dorsal and ventral disks in the form of internal impressions.

P. (Protopteraspis) gosseleti and *P. (Pr.) leathensis* are small snub-nosed species, with dorsal disk 4 cm long at most. Ridges of ornamentation 50-80 (26) per cm and A-shaped in *leathensis* (unknown in *gosseleti*). *P. leathensis* has a more rounded snout, smaller pineal plate and larger cornual plate than the other.

Pteraspis (Belgicaspis) crouchi, of medium size, dorsal disk with maximum length of 7 cm (27). Rostrum typically long, narrow and rounded. Ridges of ornamentation flattened, 50-80 per cm. Cornual plate minute.

Pteraspis (Pteraspis) rostrata, typically of medium size, dorsal disk with maximum length of 7 cm. Rostrum bluntly triangular, up to two-thirds length of disk. Ridges or ornamentation rounded, 50-80 per cm. Cornual plate with conspicuous triangular horizontal flange. Variety *monmouthensis* of large size with dorsal disk up to 10 cm in length, ridges of ornamentation 80-100 per cm.

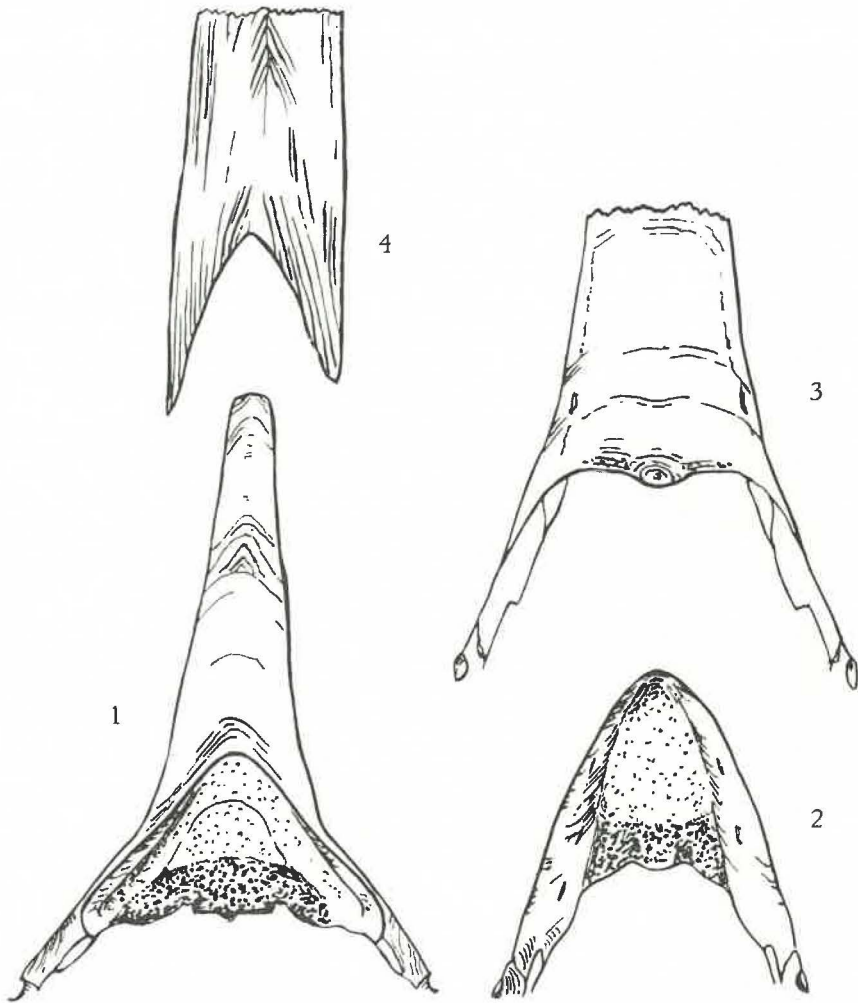
Pteraspis (?Rhinopteraspis) dewalquei of large size, dorsal disk up to 13 cm long (rostrum ? long), Ridges of ornamentation up to 160 per cm (on cornual plate). Cornual plate with pointed, backwardly directed spine.

Pteraspis (Rhinopteraspis) leachi of large size, dorsal disk up to 14 cm in length. Rostrum long, triangular, about four-fifths the length of dorsal disk. Ridges or ornamentation dead flat and closely appressed, about 60-70 per cm, those on rostrum always in form of chevrons throughout.

(25) e.g. M. LERICHE, *loc. cit.*, 1924, p. 146 : E. ASSELBERGHS, *loc. cit.*, 1955, p. 942.

(26) Near the middle of plates the ridges are usually coarser in all species, and marginally, especially in the larger specimens they are very much finer.

(27) The specimens recorded from Belgium, France and Germany are for the most part very much smaller than those from British localities.



Undersurface of rostra of *Pteraspis* spp. shewing the pre-oral areas. Partly restored.
The numbers are those of British Museum (Nat. Hist.).

1. *P. (Belgicaspis) crouchi* LANKESTER. Herefordshire, England.
P. 19142. $\times 1 \frac{3}{5}$.
2. *P. (Pteraspis) rostrata* (AG.). Herefordshire, England.
P. 5373b + 16477 $\times 1 \frac{3}{5}$.
3. *P. (Rhinopteraspis) leachi* WHITE. Swanlake Bay, S. Wales.
P. 18045. $\times 4/5$.
4. *P. (Rhinopteraspis) dunensis* (ROEMER). Young specimen.
Gemünd, Germany. P. 22043. $\times 1 \frac{1}{5}$.

Horizontal flange of cornual plate with a small posterior hook-shaped process.

Pteraspis (Rhinopteraspis) dunensis of large size, sometimes enormously so, but often no larger than the preceding species. Rostrum very long and blade-like, exceeding the length of the dorsal disk. Ornamentation flat and closely appressed, coarse, about 30-60 per cm., longitudinal on rostrum except near the posterior end where they form chevrons. Cornual plate unknown.

The ornamentation is a good specific guide in *Pteraspis* even on fragments, so long as the specimen is not worn, but if worn it becomes flat, whatever the species, but the coarseness in *P. dunensis* will usually enable small fragments to be satisfactorily identified.

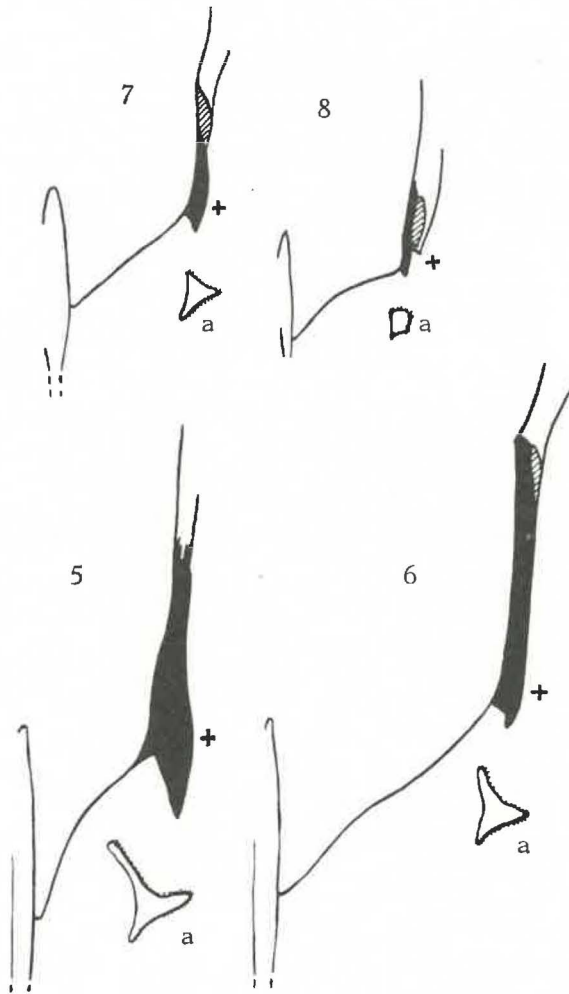
The various sub-genera into which the genus *Pteraspis* is divided were nearly all based at least on partial misunderstandings, e.g. *Protopteraspis* was erected by LERICHE for *P. gosseleti* (28) in the belief that it had no separate dorsal spine; *P. crouchi* the type-species of *Belgicaspis*, was supposed by ZYCH (29) and LERICHE to have lacked the pineal plate; while JAEKEL supposed that the shape of the scales in *Rhinopteraspis* were peculiarly long and narrow (30). However, I have been able to shew, by developing the mouth and cornual regions of a number of species, that these divisions are well founded (Text-figs 1-8). In *P. rostrata*, the type-species of the genus, the pre-oral field (the defined area in front of the mouth in which the ornamentation is broken up into fine tubercles) is well developed and the margin itself has a slight median projection; in *P. crouchi* there is a small raised pre-oral field and a curious shield-shaped projection running upwards and backwards towards the roof of the mouth; while in *P. leachi* there is no pre-oral field but a slight median projection with concentric ornamentation. In young *P. dunensis* at any rate the projection is absent. These differences are possibly connected with differences in feeding-habits.

In conclusion I wish to express again my indebtedness to Dr. E. LELOUP, the acting director, and to Professor V. VAN STRAELEN, honorary director of the Institut royal des Sciences naturelles de Belgique; to M^{me} CARPENTIER-LEJEUNE, conservateur du Laboratoire de Paléontologie Animale, Liège; to Professor E. ASSELBERGHS of the University of Louvain; to Professor R. MARLIÈRE of the Faculté Polytechnique de Mons, and to Professor G. UBAGHS of the University of Liège, to all of whom I offer my best thanks.

(28) M. LERICHE, *loc. cit.*, 1924, p. 149 (2).

(29) N. ZYCH, *Fauna ryb Dewonu i Downtonu Podola. Pteraspidomorphi Heterostraci*. Czesc I.A. Lwow, 1931, p. 86, fig. 40.

(30) O. JAEKEL, *Die Mundbildung der Placodermen*. Sitzb. Gesellsch. naturf. Freunde, Berlin, 1919, p. 74.



Right posterior regions of *Pteraspis* spp.
 shewing the cornual plates (in black) (a) enlarged cross-section at +.
 The numbers are those of British Museum (Nat. Hist.).

5. *P. (?Rhinopteraspis) dewalquei* FRAIPONT. Carlsbourg.
 Holotype. $\times 4/5$.
6. *P. (Rhinopteraspis) leachi* WHITE. Swanlake Bay, S. Wales.
 P. 18044. $\times 4/5$.
7. *P. (Pteraspis) rostrata monmouthensis* WHITE. Monmouthshire, England.
 P. 5037. $\times 4/5$.
8. *P. (Belgicaspis) crouchi* LANKESTER. Herefordshire, England.
 P. 24477. $\times 4/5$.

RÉSUMÉ.

The records of the occurrence of pteraspids in France and Belgium have been reconsidered and as many as possible of the specimens re-examined. It is pointed out that more than three different species have been recorded as '*Pteraspis dunensis*', including *P. (?Rhinopteraspis) dewalquei*, *P. (R.) leachi* and *P. (R.) dunensis* itself, each apparently with a different stratigraphical range. There is also at least one undescribed species belonging to a different sub-genus or possibly genus, also to be considered, from Vimy and perhaps also from Villance. A tentative scheme of correlation is drawn up with the corresponding strata of the Lower Old Red Sandstone in the Anglo-Welsh area.

The chief characters of the species concerned are listed, and differences in the pre-oral regions are shewn to be of sub-generic rank.

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