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HUMAN DIPHYLLOBOTHRIASIS IN PERU

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I. Identification of the Species

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Introduction

The material upon which this paper is based was provided by Dr. H. MIRANDA C from the human cases who had never left the coast of Peru and described by himself and his co-workers (II). This is the first time that in the Southern Hemisphere tapeworms from Pinnipeds are reported from man, although, in the Arctic, *Diphyllobothrium cordatum* (LEUCK.) occurs in both seals, man and dogs.

Most of the present material was well preserved as can be seen from the photographs and consequently the identification leaves no room for doubt.

All who have attempted to identify species of the genus *Diphyllobothrium* have met with great difficulties in spite of recent attempts at revision (*vide* MARKOWSKI, 1952a, b). The issue has also been confused by the fact that many authors on *a priori* grounds or from insufficient taxonomical evidence, consider the tapeworms from the northern Pinniped populations as distinct from those from the southern populations. Evidence is presented here that this is not necessarily so and that tapeworm species from the same family of hosts (*Otariidae*) occur simultaneously in both hemispheres.

The species redescribed here has been identified as *Diphyllobothrium pacificum* (NYBELIN, 1931) and its numerous synonyms and complicated history have been established.

Diphyllobothrium pacificum (NYBELIN, 1931), MARGOLIS, 1956.

Synonyms: *Bothriocephalus* sp. STILES and HASSALL, 1899.

Adenocephalus pacificus NYBELIN, 1931.

Adenocephalus septentrionalis NYBELIN, 1931.

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- Diphyllobothrium scoticum* BAYLIS, 1934 nec RENNIE and REID, 1912.
- Diphyllobothrium arctocephalinum* JOHNSTON, 1937.
- Diphyllobothrium arctocephali* DRUMMOND, 1937.
- Cordicephalus septentrionalis* (NYBELIN), WARDLE, MCLEOD and STEWART, 1947.
- Diphyllobothrium* species No 2 STUNKARD, 1948.
- Diphyllobothrium glaciale* MARKOWSKI, 1952b nec CHOLODKOWSKY, 1915.
- Diphyllobothrium krotovi* DELIAMURE, 1955.
- Diphyllobothrium pacificum* (NYBELIN), MARGOLIS, 1956.
- Diphyllobothrium latum* MIRANDA, FERNANDEZ, CASTILLO and SORIANO, 1961 nec LINNEUS, 1758.

Hosts¹. *Callorhinus ursinus* (L.), *C. u. curilensis* JORDAN and CLARK, *C. u. alascanus* JORDAN and CLARK, *Arctocephalus australis* (ZIMM.), *A. doriferus* JONES, *Neophoca cinerea* GRAY, *Otaria byroni* BLAINV., *Eumetopias jubatus* (SCHREB.), *Homo sapiens* L.

Historical. The history of this species is very complicated as is evidenced from the above list of synonyms. The first to mention this species were STILES and HASSALL (1899) who mentioned it under the name of *Bothriocephalus* sp. from the Pribilof Islands Fur Seals, *Callorhinus ursinus* (L.). More than 30 years later, NYBELIN (1931) re-examined the original material and both described and named it *Adenocephalus septentrionalis*. In the same paper, he also described as *Adenocephalus pacificus* a species taken from JUAN FERNANDEZ Islands Fur Seal, *Arctocephalus australis* (ZIMM.)². MARKOWSKI (1952b) re-examined the type specimen of *A. pacificus* and considers it identical with *A. septentrionalis*, the former name having page precedence over *A. septentrionalis*. MARKOWSKI (1952b), however, identifies the above species with *Clestobothrium glaciale* CHOLODKOWSKY, 1915 also described from the Northern Fur Seal, *C. ursinus* and which he refers to the genus *Diphyllobothrium* in spite of the dorsal opening of the uterus. NYBELIN had previously suggested that this was due to the section having been reversed accidentally³.

¹ All the hosts mentioned belong to the family *Otariidae*.

² MARKOWSKI (1952) considers *A. australis* synonymous with *Neophoca cinerea*, a species which according to WALKER (1964) is only found along the southern coast of Australia. SIVERSTEN cited by MARGOLIS (1956) states that the Juan Fernandez Fur Seal probably belongs to *Arctophoca philippi* PETERS. But the latter species, according to WALKER (*loc. cit.*), occurs only around Guadalupe Island off the coast of Lower California, whereas *A. australis* is found from Brazil, the Strait of Magellan to Peru and also around the Falkland Islands as well as the Galapagos. There is therefore no reason to doubt the correctness of the name indicated by NYBELIN for the Juan Fernandez Fur Seal.

³ During a recent visit to Leningrad, Academician BYCHOWSKY informed me that CHOLODKOWSKY's types and collections were destroyed by the bombardment of Leningrad during the Second World War. Consequently, the species *glaciale* should no longer be considered valid, since its generic attribution remains open to doubt.

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BAYLIS (1934) identified as *Diphyllobothrium scoticum* RENNIE and REID, 1912 tapeworms from *Otaria byronia* BLAINV. These specimens were described by MARKOWSKI (*loc. cit.*) under the same name, even though he mentioned that the eggs were smaller than those from specimens of this species previously identified by himself (1952a) from a Leopard Seal, *Hydrurga leptonyx*. A re-examination of BAYLIS' material has shown it to belong to *D. pacificum* and therefore to be distinct from *D. scoticum*⁴.

Diphyllobothrium arctocephalinum JOHNSTON, 1937 from the Southern Fur Seal, *Neophoca cinerea*, and *Diphyllobothrium arctocephali* DRUMMOND, 1937 from the Tasmanian Seal, *Arctocephalus doriferus*, are considered by MARKOWSKI (1952b) to be synonymous with *D. scoticum* BAYLIS *nec* RENNIE and REID and this is substantiated by the present study. STUNKARD (1948), apparently unaware of NYBELIN's paper, redescribed part of STILES and HASSALL's original material as *Diphyllobothrium* species No 2, whereas YAMAGUTI (1951) figures the species as *Adenocephalus pacificus* from the Northern Fur Seals, *C. ursinus*, in the Northern Pacific. DELLAMURE (1955), unaware of MARKOWSKI's two papers, describes *Diphyllobothrium krotovi* from *Callorhinus ursinus curilensis* JORDAN and CLARK and *C. u. alascanus* JORDAN and CLARK and considers it to be identical with STILES and HASSALL's specimens. Finally, MARGOLIS (1956) describes *D. pacificum* from *Eumetopias jubatus* (SCHREB.) from Quatsino Sound, Vancouver Island. More recently, MIRANDA, FERNANDEZ, CASTILLO and SORIANO (1961) published the first report of *D. pacificum* from man from the coast of northern Peru. Owing to lack of comparative material, this was identified as *D. latum*, the diagnosis being later confirmed by Dr. ARANDAS REGO from the Oswaldo Cruz Institute in Brazil. A re-examination of the original material has, however, shown that it belongs to *D. pacificum*.

A scolex was recovered from a recent case; it is slightly macerated and measures 3 mm in length and 1 mm in width (Fig. 1). From previous descriptions (NYBELIN, JOHNSTON, STUNKARD, YAMAGUTI) the scolex is 1.3—2.5 mm long and 0.6—1.5 mm in maximum breadth. The pseudobothridia contain deeply staining glandular tissue. There is a short neck-region. The length of the strobila of the human cases varies from 300—1960 mm. This is considerably longer than the specimens previously described from seals in which the length varies from about 50—250 mm, but this is very probably due to the fact that this species is usually found in large numbers in these hosts, whereas in the human cases

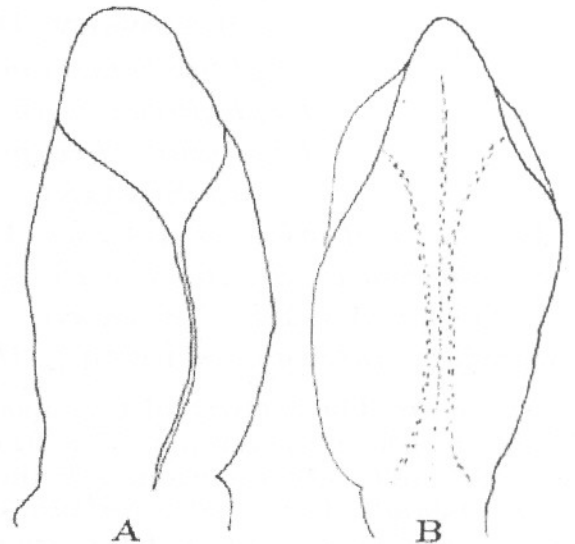


Fig. 1A and B. Scolex of *D. pacificum*.
A Ventral view; B lateral view

⁴ I am grateful to Dr. S. PRUDHOE for having made available for study BAYLIS' slides deposited in the British Museum (Nat. Hist.).

there was only a single worm⁵. There is no doubt whatever that in the genus *Diphyllobothrium*, the crowding effect is very pronounced.

The greatest width of the specimens varies from 5—10 mm in proglottids containing a fully developed uterus. The length of individual proglottids varies greatly according to their position within the stro-

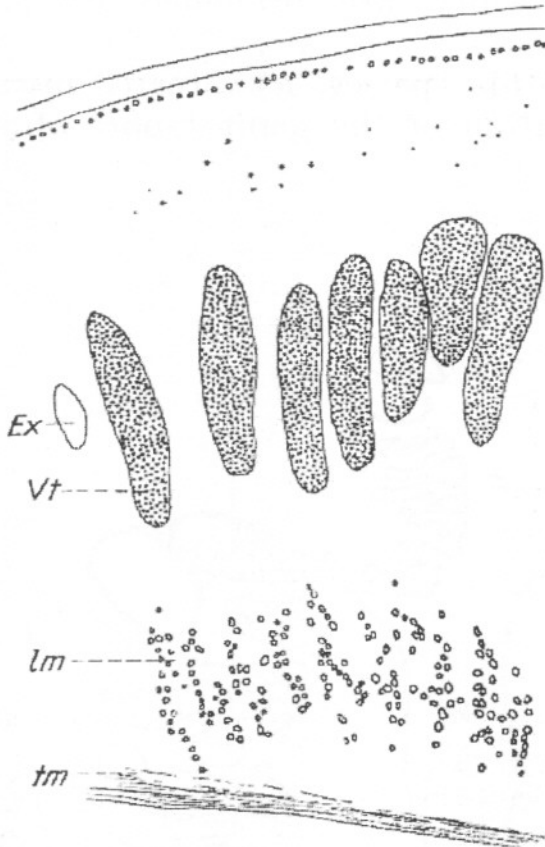


Fig. 2

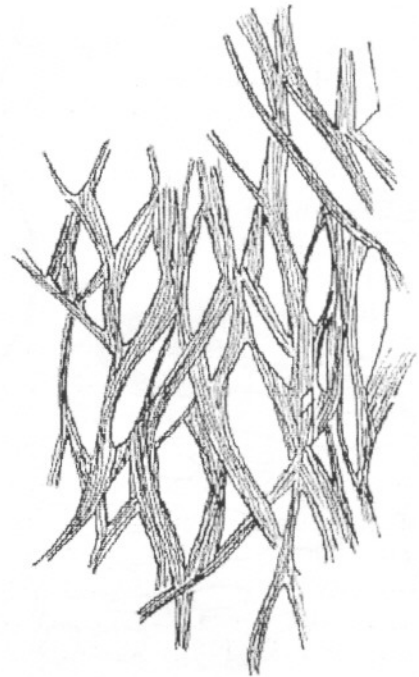


Fig. 3

Fig. 2. Portion of a transverse section to show the longitudinal musculature. *Ex* excretory vessel, *lm* longitudinal musculature, *tm* transverse musculature, *Vt* vitellarian follicles

Fig. 3. A horizontal section showing the reticulate arrangement of the longitudinal musculature

bila, the most posterior ones being apparently the shortest. It is however well known that these proportions vary to a very great extent and cannot be used for distinguishing species of *Diphyllobothrium* from one another (*vide* RAUSCH, 1954)⁶.

MARKOWSKI (1952a, b) has stressed the structure and development of the longitudinal musculature of the strobila. In this species it has

⁵ *D. latum*, in man, attains a length of about 10 m, but in dogs and cats, the length is hardly ever greater than 1 m. In a human case from Neuchâtel in which four worms were expelled simultaneously, the length of each was less than 2 m and the greatest width 5 mm.

⁶ In a recent case not included among the seven described, parts of the strobila were fenestrated, an anomaly which also occurs in other tapeworms.

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been described as very well developed. In the Peruvian specimens, there are about 20 layers of fibres, but it should be borne in mind that the longitudinal muscle fibres are arranged in a net-work (Fig. 3) and consequently their individual position on a transverse section can vary considerably from one section to another. This also applies to the longitudinal excretory vessels which are branched irregularly (see Fig. 5B).

A distinguishing feature of this species, as already mentioned by MARKOWSKI (1952b), is the position of the genital pore almost in the

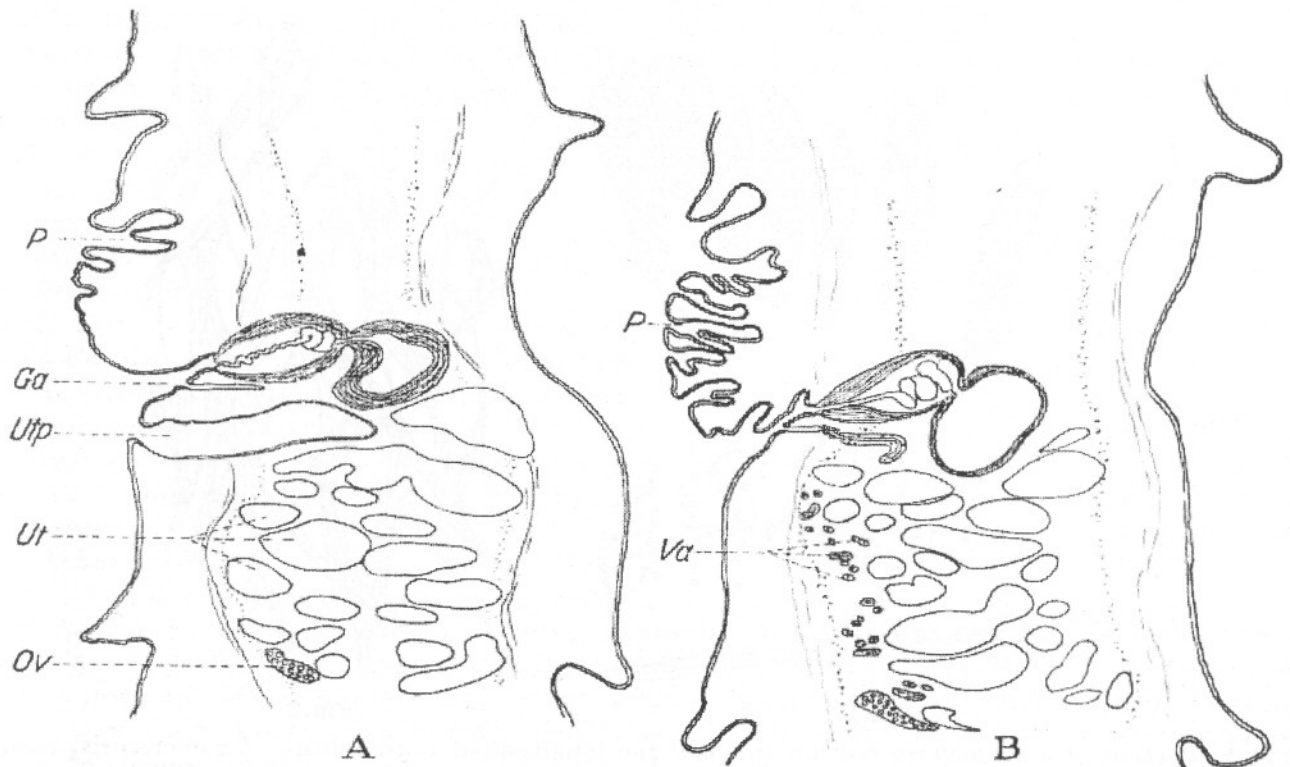


Fig. 4A and B. Sagittal sections from two different strobilae. A Passing through the uterine pore; B Showing the vagina. *Ga* genital atrium, *Ov* ovary, *P* "pits" on the ventral surface, anterior to the genital pore, *Ut* uterus, *Utp* uterine pore, *Va* vagina

middle of the proglottid. JOHNSTON (1937), DRUMMOND (1937), and STUNKARD (1948) have described a series of transverse pits situated between the anterior border of the proglottid and the genital pore. These pits are also visible in all of the human specimens (Fig. 5), although less evident in the widest proglottids (Fig. 7A). Although NYBELIN (1931) does not mention this character, it is clear from the sagittal section of *A. septentrionalis* (Pl. 17, Fig. 9) that such pits are also found in this species. On the other hand, they have not been observed in *A. pacificus* although their existence may be deduced from Fig. 2, pl. 17, a sagittal section of this species.

The position of the genital pore in the Peruvian specimens is either central or nearer to the anterior edge of the proglottid. There is a very

shallow genital atrium which appears to be much deeper owing to the curious structure of the proglottid anterior to the genital pore. The cirrus pouch is 180—320 μ long with a maximum diameter of 114—250 μ . The wall of the cirrus pouch is thick but the muscle fibres are exceedingly fine and stain lightly. The cirrus occupies about half of the pouch

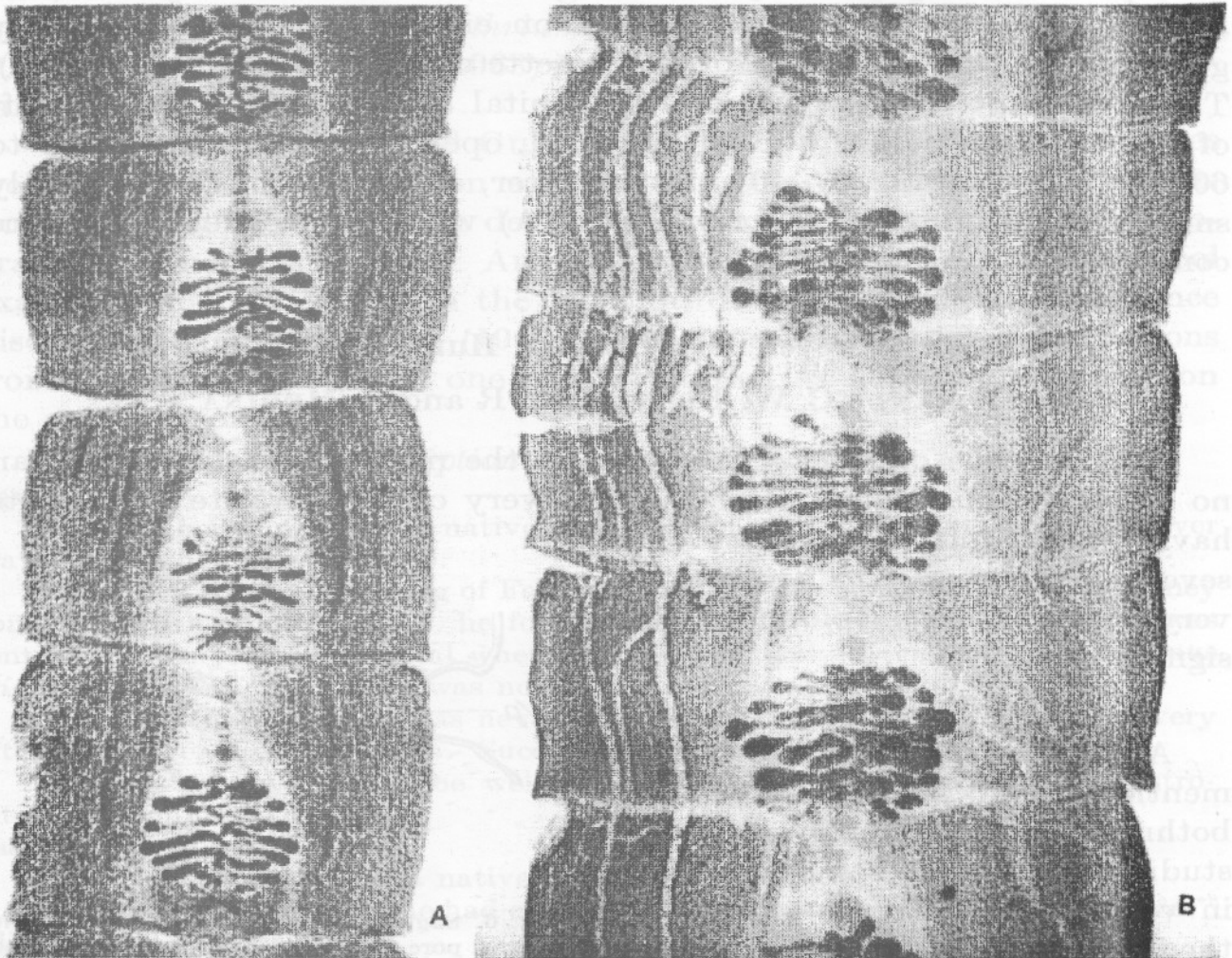


Fig. 5 A and B. Two fragments of the same strobila in which the "pits" are clearly visible anterior to the genital pore. A Younger proglottids; B older proglottids in which part of the excretory system can be seen

whereas in the proximal half is found a dilated *vas deferens*. The external seminal vesicle is large and muscular measuring 114—250 μ in diameter. The testes occupy two lateral fields on either side of the genital complex, and in contracted specimens, testes are also seen anterior to the genital pore. Their total number is about 500—650; they form a single layer and each testes lies with its longitudinal axis in a dorsoventral plane.

The vagina opens behind the cirrus pouch through a rather narrow segment lined by a cuticula, this segment passes abruptly into the true vagina which can be recognized by its thick wall in which are seen

nuclei. Close to the junction of these two segments, the vagina is surrounded by several layers of circular muscle-fibres which form a closing mechanism. The only author who mentions this structure is NYBELIN (*loc. cit.*) although he does not include it in his drawings. This character has been found in all of the specimens examined as well as in the specimens reported by BAYLIS (1934) from *Otaria byroni* (*vide supra*). The uterus forms 4—7 loops on either side but even in fully gravid proglottids, it never forms a rosette as in *D. latum* (see Fig. 7 B). The uterine pore opens behind the genital atrium slightly to the left of the latter. The eggs are thick-shelled, operculated, measuring 50 to 60 μ in length and 36—40 μ in diameter, they are thus considerably smaller than those of *D. latum* (Fig. 8A) with which they cannot be confused.

II. Description of Seven New Cases of Human Diphyllbothriasis

H. MIRANDA C, W. FERNANDEZ R and J. MEDINA T

The presence of *Diphyllbothrium* in the northern part of Peru can no longer be questioned after the discovery of the parasite in patients having never left the country. The seven cases referred to here have a very remarkable epidemiological significance.

Historical

AYULO and FILOMENO (1957) mentioned two cases of Diphyllbothriasis in an extensive series of studies on parasitoses undertaken in various parts of the country by themselves as well as by others. The reference is very brief and contains no further information on these cases.

GUERRERO (1962) discovered among preserved material a specimen of *D. latum* from a dog but without any case history. The same author again found the parasite in a five months' old dog brought over from Europe at the age of two months.

The first description of a human case duly documented was reported by MIRANDA, FERNANDEZ, CASTILLO and SORIANO (1961). The patient, a native of Trujillo, had never travelled outside the country. The parasite was identified as *Diphyllbothrium latum* (L.) and this was later confirmed by Dr. ARANDAS REGO of the Oswaldo Cruz Institute of Brazil.

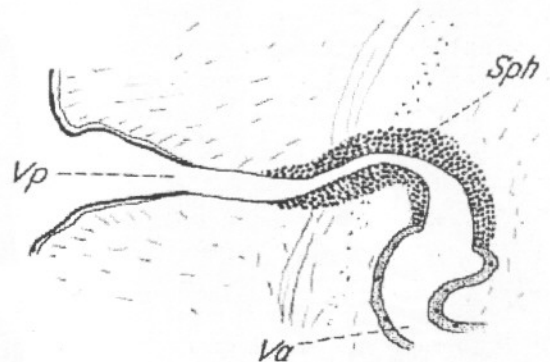


Fig. 6. Sagittal section passing through the vaginal pore. *Sph* circular muscles surrounding the distal portion of the vagina; *Va* vagina with characteristic cellular lining; *Vp* vaginal pore

A few months later, CASTILLO, IBANEZ and ARRASCO (1962) found a second case in a patient from Chiclayo. The complete removal of the parasite was achieved although the identification was not confirmed. A new case was presented by GUEVARA and VILLANUEVA (1964) at the National Congress of Microbiology and Parasitology. A specific identification was not made but enough evidence was present to attribute it to the genus *Diphyllobothrium*. Another case was discovered by PAREDES and LOPEZ DIAZ (1963) in a child who had never left its mountain village of La Oroya.

GUTIERREZ, ROBLES and GUTIERREZ (1965) published five new cases from Lima. The identification was made by Drs. GUERRERO and MCGREGOR who assumed they were dealing with *D. latum* although the photographs are not very useful. ARRASCO (1965), in a series of 1000 stool examinations carried out in the Hospital of Belén (Trujillo), only once discovered eggs. CHIRINOS (1965), in 1320 routine stool examinations from Chiclayo, also found one case diagnosed as Diphyllbothriasis on the presence of ova.

Description of Seven New Cases

Case No 1

L. L. A.; male; 4 years; a native and resident of Pacasmayo, who has never travelled further than Trujillo.

Symptoms. At the beginning of February, 1965, while being treated for a kidney complaint with chloromycetin, he found a flatworm in his feces. The worm was sent to the University Hospital where it was identified as belonging to the genus *Diphyllobothrium*. The scolex was not found and the total length was 34 cm.

Personal habits. His diet has never included fresh-water fish. The family very often eats a sea fish known as "Suco" (*Paralonchurus peruanus*).

The patient appeared to be well nourished and showed no signs of gastrointestinal symptoms.

Case No 2

L. K.; female; 14 years; a native of Trujillo; a student.

The patient stated that she had evacuated a flat parasite after taking "weaver" oil⁷.

Symptoms. A few months previously she complained of having had headache and frequent nausea. No change of weight was observed.

Personal habits. Has never eaten trout or any fresh-water fish but often eats "Bonito", "Suco" and rarely "Corvina" (*Sciaena deliciosa*).

The worm had a central uterus and was identified as *Diphyllobothrium*. The length was 30 cm.

Case No 3

Female; 21 years; a medical student, native of Trujillo.

Symptoms. None.

Personal habits. Has not eaten fresh-water fish but eats "Suco", "Liza" (*Mugil* sp.) and occasionally "Corvina" in the form of "ceviche"⁷.

A flat worm with central uterus was evacuated, the length being 60 cm.

Case No 4

⁷ A dish of fish prepared with lemon juice, which probably does not affect the plerocercoid larvae.

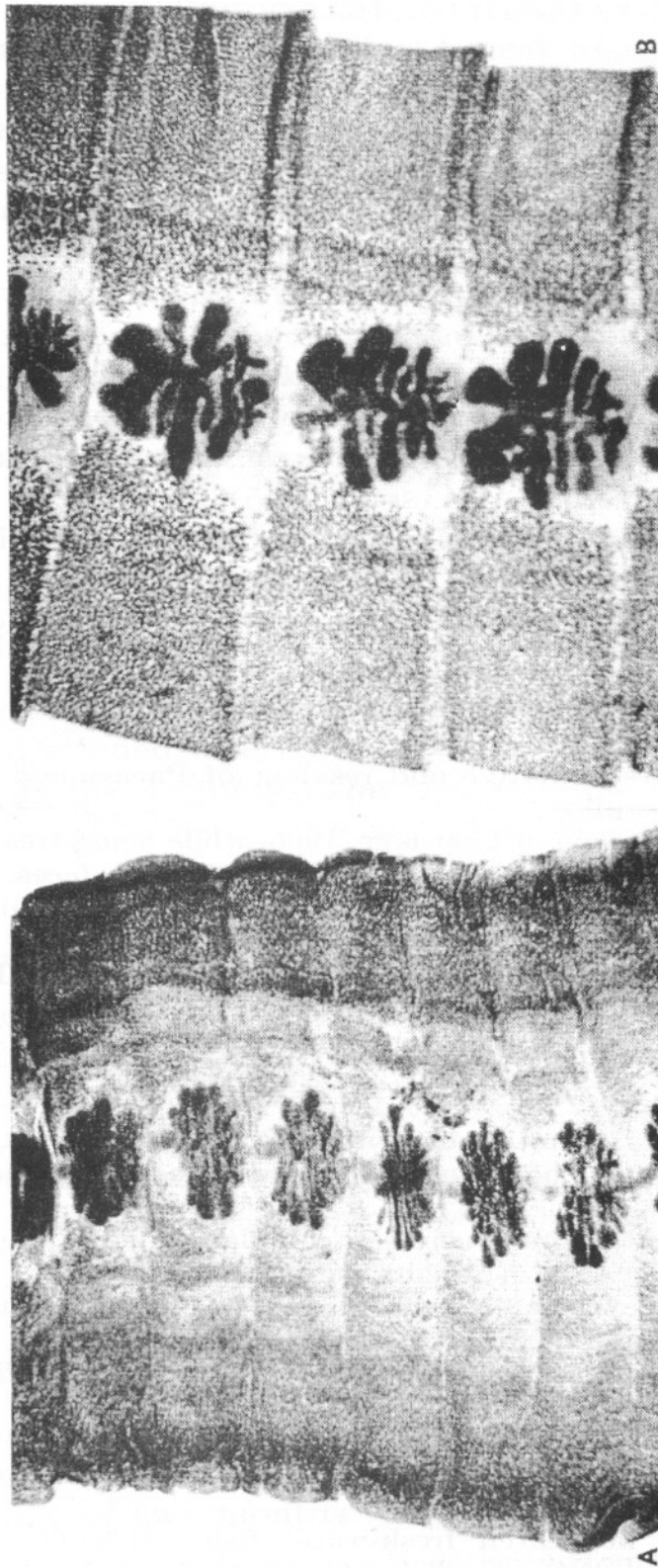


Fig. 7. A Gravid proglotidids from the same strobila as Fig. 4. B Gravid proglotidid from *D. latum* for comparison

Female; 7 years; native of Cartavio.

Symptoms. None.

Personal habits. Never eats fresh-water fish. She eats the same fish as in the previous case and also "Mono" (*Sarda chilensis*).

Length of the worm: 47 cm.

Case No 5

Male; 23 years; medical student, a native of Trujillo.

Symptoms. None.

Personal habits. Has not eaten fresh-water fish. Eats the same species of fish as case No 3, also in the form of "ceviche".

The worm was evacuated spontaneously; its length is 196 cm.

Case No 6

W. U.; male; 26 years; born in Santiago de Chuco.

Symptoms. Since 3 months epigastric pains which decrease after meals. Loss of weight in the last months. Nausea and intensive salivation occurring sometimes in the morning.

Examinations. Numerous ova of *Diphyllobothrium* in the stools on two different occasions. No anaemia nor eosinophilia.

Expulsion of the worm was unsuccessful using as much Metochin as Yomesan (Bayer).

Case No 7

S. O.; female; 30 years; born in Otuzco where she lived before moving to Trujillo, six years ago.

Symptoms. Frequent headache and nausea. Has gained 2 kg in the last two months. The patient consulted her doctor after eliminating a piece of a flat worm identified as belonging to the genus *Diphyllobothrium*. No scolex was seen and the total length was 40 cm.

Personal habits. Has not consumed fresh-water fish, but often eats "Suco", "Mono", "Bonito", "Liza" and "Corvina".

III. Conclusions

The identification of the specimens from the seven cases reported above, leaves no doubt as to their belonging to the species *D. pacificum*. But the history of diphyllobothriasis in Peru does not completely exclude the possibility of *D. latum* also being found there, even though there does not appear to exist any definite proof. Mistakes occur frequently in identifying species of *Diphyllobothrium* when comparative material is unavailable and for this reason we publish photographs of gravid segments as well as of ova of both these species (Fig. 7). The ova especially make a differential diagnosis possible (Fig. 8).

D. latum is a species common in fish-eating mammals from the Northern Hemisphere and its presence south of the equator could only be due to an accidental introduction even though this does not necessarily mean that the species has become established and that a suitable second intermediate host is present. Judging from the fairly recent introduction of *D. latum* into Chile, it is clear that the species has become endemic because trout has also been introduced since there are no autochthonous salmonids in the Southern Hemisphere. It should be borne in mind that similar conditions might arise in some regions of Peru.

As already pointed out by BAER (1940), *D. latum* has never been reported from pinnipeds and that this error of hosts has been caused by a mistranslation of M. BRAUN's original paper in German.

The likelihood that the same species of *Diphyllobothrium* occurs in both marine and land mammals having access to fresh-water, might appear improbable unless the second intermediate host is an anadromous fish. This is the case for *D. cordatum* reported from seals, dogs and man in the Northern Hemisphere and of which the plerocercoid larvae will be found most probably in salmonids (*vide* RAUSCH *loc. cit.*).

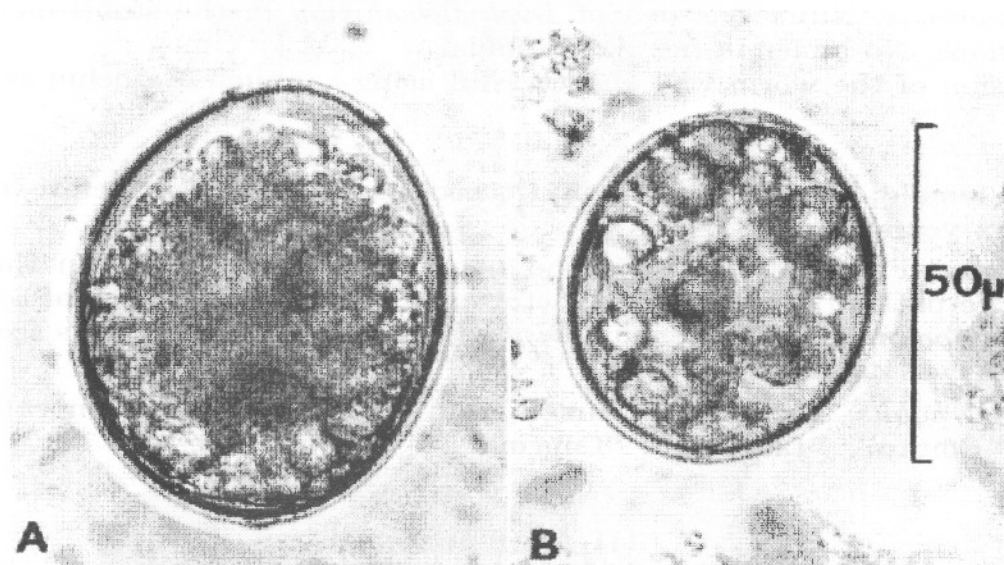


Fig. 8. A Ovum of *D. latum*. B Ovum of *D. pacificum*

From an epidemiological point of view, the seven cases reported above from man are most illuminating since the patients only ate sea fish and had never left the coastal area of Peru. Plerocercoid larvae have not yet been discovered in the above mentioned fish, their presence is almost certain and dogs could probably be infested experimentally, or may even be found to harbour natural infestations.

On the other hand, at least two species of seals, *Otaria byroni* and *Arctocephalus australis*, occur off the coast of Peru, and both of these hosts are known to harbour *D. pacificum*. It is therefore easy to understand how the fishes may acquire their plerocercoid larvae.

Since *D. pacificum* also occurs in the Northern Fur Seal, *Callorhinus ursinus*, it also becomes a potential human parasite in the Northern Hemisphere.

Summary

Diphyllobothrium pacificum, a tapeworm from seals, is reported for the first time from man in Peru. Seven further cases are described from people living along the coast and whose food includes various species

of sea fish. The very complicated history of the parasite which involves numerous synonyms has been established. This is also first report of human diphyllbothriasis other than *D. latum* from the Southern Hemisphere.

Résumé

Diphyllbothrium pacificum, un cestode d'otaries, est signalé pour la première fois chez l'homme au Pérou. Sept nouveaux cas sont décrits chez des personnes habitant la région côtière et mangeant du poisson marin. L'histoire très compliquée de ce ver impliquant de nombreux synonymes, a été établie. C'est également la première fois que l'on signale une diphyllbothriase humaine autre que *D. latum* dans l'Hémisphère Sud.

Resumen

Diphyllbothrium pacificum, un cestodo de las otarias, es señalado por la primera vez como parásito humano en el Perú. Siete casos mas son descritos en los habitantes de la costa en cuya alimentación entra el pescado de mar. Se ha podido establecer la historia muy complicada de este helminto, la cual implica una multitud de sinónimos. Es igualmente la primera vez que se ha señalado una difilobotriasis humana en el Hemisferio Sur que no sea causada por el *D. latum*.

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