New Cestode of the Genera *Diplopylidium* (Eucestoda:Dipylidiiae) Parasitizing *Felis domesticus* in Maharashtra: A Morphological Study

**Abstract:**

*Diplopylidium alii* n. sp. belonging to order Dilepididea is described from *Felis domesticus* collected from Tal. Jalna of Jalna district, M.S. India. The collected cestodes were flattened and preserved in formalin. The preserved worms were stained with Harris haematoxylene, dehydrated in alcohol and mounted in D.P.X. Figures were drawn using camera lucida. The present species has dome shaped scolex; rostellar hooks in 6 rows and 38 in number; testes medium, almost round, 215-225 (219) in number; cirrus pouch large, sickle shaped; ovary distinctly bilobed; vagina is posterior to the cirrus pouch and vitelline gland medium in size, triangular with irregular margin. The present worm has significant morphological variations to accommodate it as a new species.

**Keywords:** Cestoda; *Diplopylidium alii n*. sp.; *Felis domesticus*; Jalna.

1. **Introduction:**

Beddard in 1913 erected the genus *Diplopylidium* (Syn. *Progynopylidium*) with type species *D. genattae from Genettta dongolana.* Later, more species were added to this genus1,2. It includes D. *acanthotretum*3,4; *D. fabulosum* Meggitt, 1927 (syn. *of Joyeuxiella pasqualei*)5; *D. monoophorum*4,6,7; *D. nolleri*2 (syn. of *Dipylidium trinchesii*)9–11; *D. quinquecoronatum* 12(syn. of *D. acanthotretum*)3,8,11*; D. skrjabini*13,14*;* *D. trinchesii*15 (probably *Cysticercus acanthotreta*)3,16; . *D. triseriale*6,7. *D. zschokkei*8,17.

Although Yamaguti18 considered above species of Diplopylidium to be valid he added a foot note on in his discussion that i.e. *D. fabulosum, D. quinquecaronatum, D. trinchesii* and *D. triseriale* are regarded by Witenberg4 as identical with *D. acanthotretum* but has not given his opinion clearly.

One new species *Diplopylidium polyacantha*19 and eight new species from India viz, *D. udgirensis*20, *D. iayashreeae*21, *D. aurangabadensis*22, *D. shindei*23, *D. parvatiae*24*, D. shindei*25, *D. murtizarpurensis*26 and *D. chandensi*27 were added to this genus. All seven species from India except *D. chandensis*27 deemed invalid as *Diplopylidium* and instead reclassified under *Joyeuxiella* due to discrepancies in genital anatomy and hook morphology28.

The present communication deals with the description, of a new species, under the same genus, as D. alii n.sp..

1. **Methodology:**

**2.1 Materials and Methods**

Fifteen cestode worms were obtained from the small intestine of a domestic cat, *Felis domesticus*, at Jalna, District Jalna, M.S., India in the month of November 1997. These cestodes were flattened between glass slides and preserved in 4% formalin. For further anatomical studies the preserved cestodes were washed with water and stained using Harris haematoxylin. The stained cestodes were dehydrated by passing through various concentration grades of ethanol, cleared in xylol and whole mount slides were prepared in D.P.X. Sketches were made using camera lucida. Measurements are recorded in mm. The whole mount slides are preserved in Zoology Department of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India. Classification and relevant description of genus *Diplopylidium* has been obtained from the available literature resources18,29.

1. **Result and Discussion**

The parasites were medium in length, whitish with scolex, numerous immature and mature proglottids. Fig. 1 shows the morphometric details of *Diplopylidium alii sp. nov*. Scolex large, dome shaped, distinctly marked off from the strobila, narrow anteriorly, broad posteriorly, with armed rostellum and measures 0.306 to 0.350 x 0.291 to 0.417. The scolex bears four medium, oval suckers, arranged in two pairs, one pair in each half of the scolex slightly overlapping on each other and measure 0.092 to 0.112 x 0.083 to 0.107

Rostellum medium, oval, armed with hooks, present at the apex of scolex and measures 0.083 to 0.107 x 0.136 to 0.199. The rostellar hooks are present on rostellum, which are small in size, bipronged in nature, with unequal prongs, 38 in number, arranged in 6 rows, as follows: I row - 4, II row - 2, III row - 6, IV row - 11, V row - 4, VI row - 11; The rostellar hooks are of two types, large and small. In larger hooks the long prong measures 0.046 x 0.001 to 0.008, while smaller prong measures 0.041 x 0.002 to 0.008. In smaller hooks the long prong measures 0.019 x 0.001 to 0.002, while the smaller prong measures 0.015 x 0.002.

The neck is medium, cylindrical, broad anteriorly, narrow posteriorly, measures 1.248 to 1.262 x 0.194 to 0.451. Mature proglottids medium, rectangular, longer than broad, slightly convex lateral margins, short, blunt projections at the posterior corners of the segments with a pair of genitalia and measure 0.728 to 0.762 x 0.417 to 0.543.

The testes are medium, almost round 215 – 225 (219) in number, in a unevenly distributed in single field in the central medulla, from the anterior to the posterior and from one lateral to the other lateral margin of the segments, restricted laterally by the longitudinal excretory canals, few present on or outside the same measuring 0.015 to 0.039 in diameter.

Cirrus pouch large, sickle shaped, narrow proximally, broad distally, curved anteriorly, extends medially, almost up to the centre of the segments, situated in anterior 1/4th to 1/5th region of the segments and measuring 0.223 to 0.267 x 0.010 to 0.053.The cirrus is thin, stout, coiled, contained within the cirrus pouch and measuring 0.335 to 0.403 x 0.005.Vas deferens is medium in length, very much coiled, anteriorly directed and measures 0.456 to 0.504 x 0.005.

Ovary one on each side, medium, distinctly bilobed, dumbbell shaped, having irregular margin, with numerous short, blunt, round acini, situated in the anterior half, obliquely placed and measures 0.131 x 0.049 to 0.067. The vagina is a thin tube, posterior to the cirrus pouch, starts from the genital pore, extends obliquely and posteriorly, crosses the longitudinal excretory canal, and opens into the ootype measuring 0.218 to 0.291 x 0.005. Ootype is small, oval to round in shape, present ventrally between two ovarian lobes measuring 0.010 to 0.015 x 0.010 and 0.010 in diameter.

Genital atrium oval, large, bilateral reaching medially, up to the longitudinal excretory canals, situated in the anterior one-fourth to one fifth region of proglottid measuring 0.043 to 0.072 x 0.112 to 0.370. The genital pores are large, oval, bilateral, situated in the anterior one fourth to one fifth of the segments measuring 0.049 to 0.083 x 0.015 to 0.029. Vitelline gland, one on each side, medium, globular with numerous short, blunt, round acini: obliquely placed measuring 0.039 to 0.043 x 0.024 to 0.039. Longitudinal excretory canals medium measuring 0.005 to 0.015 in width.

The worm under discussion, is having the scolex large, dome shaped; rostellum armed, with 6 rows of hooks, 38 in number, bipronged; mature segments medium, rectangular; testes medium, round, 215-225 (219) in number; cirrus pouch large, sickle shaped, reaches beyond the excretory canals; ovary medium, distinctly bilobed, with numerous short, blunt, round, acini; vagina thin, long, posterior to cirrus pouch; genital pores, large, oval in the anterior one-fourth to one-fifth of the segments; vitelline gland medium, globular or triangular and post ovarian.

The present cestode, in having 6 rows of rostellar hooks comes closer to *D. acanthotretum, D. nolleri, D. triseriale, D. zschokkei, D. polycantha* and *D. chandensis*

1. The worm under discussion, differs from *D. acanthotretum* which is having rostellum with 3-5 circles of hook 18-24 hooks per circle; neck as wide as hold fast, cirrus pouch 0.160 - 0.310, genital pores and ovary not mentioned.
2. The present form differs from *D. nolleri* which is having rostellum with 3-4 circles of hooks, 100 hooks, neck narrower than holdfast; cirrus pouch not mentioned; genital pores at 1/5th or 1/7th of segment margin and ovary not described.
3. The present cestode, differs from *D. triseriale*, which is having rostellum with 3 circles of hooks; neck not mentioned, genital pores in 1/3rd or 1/4th of segment margin; cirrus pouch 0.280 X 0.050-0.060; ovary not stated.
4. The tapeworm under discussion, differs from *D. zschokkei*, which is having rostellum with 3 circles of hooks; neck not mentioned; cirrus pouch 0.185 × 0.065; genital apertures in 1/4th of segment margin and ovary not mentioned
5. The worm under discussion, differs from *D. polycantha* which is having rostellum with 9 (8-11) circles of hook total 200 in number; neck short, cirrus pouch 0.18–0.24 mm x 0.044–0.049 mm, genital pores in the hermaphroditic proglottids is marginal, closer to the anterior edge of the proglottid, 0.11–0.16 mm from it, and ovary bi-lobed and lies posterior to the pouch.
6. The worm under discussion, differs from *D. chandensis* which is having rostellum with 7 rows of hook 200 in number; neck medium, cirrus pouch not described, genital pores situated at 1,4th from anterior margin of segment, and ovary indistinctly bi-lobed and lies anterior or middle of segment.

The additional characters are shown in the comparative chart.



**Fig. 1. Camera lucida diagram of *Diplopylidium alii* sp. nov. (A – Scolex, B – Hooks, C – Mature proglottid)**

**Table 1. Summary chart of known species of *Diplopylidium* (Beddard, 1913) on the basis of published records.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Characters | Diplopylidium acanthotretum3 | D. nolleri2 | D. skrjabini14 | D. monoophorum6 | D. genettae1 | D. trinchesii15 | D. fabulosum | D. triseriale6 | D. quinquecoronatum12 | D. Zschokkei 8,17 | D. polycantha 19 | D chandensis 27 | D. aliin. sp. |
| Length | 40 – 122  | 40 – 50  | 430 – 510  | 10 – 14  | Small form, 6 | Body length 25 | 10  | 15-25 | 20 | 120  | Incomplete strobila length 25 (20-40)  | -- | -- |
| Rostellum | .0.060-0.200 in diameter | 0.200-0.300 in diameter  | 0.090  | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.083-0.107 x 0.136-0.199  |
| Hooks | 3-5 circles of hooks, 18-24 hooks per circles | 3-4 circles of 100 hooks, 0.048-0.058 in first circle to 0.010 in last. | 4 circles of hooks, 11 hooks per circle. | 3 crowns of hooks | 2 crowns of hooks 34 per circle | 4 circles 78-85 hooks  | 4 circles of hooks | 3 circles of hooks | 5 (rarely 4) circles of hooks. | 3 circles of hooks | 9 (8–11) rows of blade like hooks, 200 in number | 7 rows, bipronged hooks 52 in number | 6 rows of bipronged hooks38 in number |
| Ist Circle | 0.062 – 0.073  | 0.042 – 0.054 | 0.042  | 0.036  | 0.063  | 0.062  | 0.070  | 0.063 – 0.068  | 0.070-0.078  | 0.045  | first row 0.065–0.071  | All hooks0.046-0.063x 0.018-0.016  | Long hooks Long prong - 0.046 × 0.008 Small prong - 0.041 × 0.008 Small hooks Long prong - 0.019 x 0.002 Small prong - 0.015 x 0.002  |
| IInd circle | 0.052 – 0.060  | 0.034 – 40.06  | 0.019  | 0.030  | 0.056 – 0.060 | 0.058 – 0.060  | 0.045 – 0.050  | 0.052 – 0.056  | 0.056-0.060  | 0.030  | second row 0.057–0.065  |
| IIIrd circle | 0.026 – 0.036  | 0.01l – 0.020  | 0.012  | 0.020 | 0.031  | 0.031  | 0.030 – 0.033  | 0.038 – 0.042  | 0.036-0.041  | 0.017  | 0.038–0.040  |
| IVth circle | 0.016 – 0.024  | 0.007 – 0.019  | 0.007 |  | 0.015 in length | 0.015 in length | 0.024  | -- | 0.022-0.030  | -- | 0.008–0.0140  |
| Vth circle | 0.011 – 0.016 in length | -- | --- | -- | -- | -- | -- | -- | 0.013-0.017 in length | -- | 0.008–0.0140  |
| Neck | As wide as holdfast | Neck narrower than holdfast | 83 long | -- | -- | Short | -- | -- | -- | --- | short, 0.71 (0.60–0.71). | Medium0.631-0.655x 0.209-0.364  | Medium 1.248 to 1.262 x 0.194 to 0.451  |
| Segment | 8 - 50 | 25 - 120  | 56 - 60 | -- | 28 segments | --- | -- | -- | -- | -- | 48 | numerous | -- |
| Testes | 30-60 in number0.030 – 0.070 in diameter | 12 - 16 in number | 12 in number, each testis 0.015- 0.018 in diameter  | 25-29 in number each 0.040 in diameter. | Numerous testes -- | 41 in number -- | 36 - 39 in number | 39 - 44 in number | 48-64 in number, each testis 0.046 in diameter. | 30 in number | 32–56round, 0.034–0.050  | 30 in number0.019 x 0.015-0.039 in size | 215 - 225 (219)0.015 to 0.039 in diameter |
| Cirrus pouch | 0.0160 – 0.0310  | -- | -- | 0.150 x 0.050 Pear shaped, curved | -- | -- | 0.217 – 0.280 x 0.035 – 0.050  | 0.280 x0.050 – 0.060  | 0.150 x0.0 50  | 0.185 x 0.065  | 0.18–0.24 x 0.044–0.049 transversely in the anterior part of the proglottid | -- | 0.223-0.267 x 0.010-0.053Sickle shapedpresent in anterior 1/4th to 1/5th of segment margin  |
| Genital pore | -- | present in first, fifth or seventh of segmental margin. | -- | present in first fifth of segment margin. | present in first fourth of segment margin | Present in first third or fifth/fourth segment margin | present in first fourth of segment margin | present in first, third or fourth of segment margin. | present in first, fourth or fifth of segment | present in first, fourth of segment margin. | marginal, near anterior edge of the proglottid | situated almost at 1/4th from the anterior margin of the segment |  |
| Ovary | -- | -- | -- | ovoid, with single lobe  | Ovarian lobes spherical | Ovarian lobes spherical | -- | -- | -- | -- | bi-lobed | Indistinctly bilobed | Bilobed, with irregular margin.  |
| Uterine capsule | -- | Uterine capsule laying inside the area. | -- | Uterine capsule restricts to area between osmoregulatory canals. | Uterine capsules between osmoregulatory | Uterine capsules between osmoregulatory | Uterine capsules between osmoregulatory canals. | Uterine capsules crossing osmoregulatory canals by  | Uterine capsules crossing osmoregulatory canals | Uterine capsules spreading over the osmoregulatory canals. | Uterus between the excretory canals | --- | -- |
| Eggs capsule | 0.057-0.083  | 0.070 – 0.170  | 0.080-0.083  | 0.036 -0.0 43  | -- | -- | -- | -- | 0.058 – 0.063  | 0.020 – 0.040  | -- | -- | -- |
| Eggs | 0.040 – 0.050  | 0.030  | -- | 0.041 in diameter | -- | -- | -- | 0.037  | 0.038 -0.0 41  | -- | 0.038–0.055 (0.033–0.071)  | -- | -- |
| Host | Dogs, Red fox, Domestic cat, African Civet cat | Dogs, Red fox and Domestic cat | Dogs and Cats | Caspian geckos, *Civettictis civetta* and *Genetta afra* | Common genetCats | -- | Cat | Genet | Cat | *Cynicitis penisillata* | Dogs, Red fox and Domestic cat, Jungle cat, Sand cat | *Felis chaus* | *Cat Felis domesticus* |
| Locality | Sardinia, Europe, Palestine | Russia Turkestan, Spain, Egypt, Turky, China, India, Cyprus, Palestine, Azerbiadzhan. | Karabach/ Azerbaidzan | Tunisia, France, Guinea, Spain, Egypt and Palestine | London Zoological gaedenNapoes, Alexandria (Egypt) | Italy, Spain, Algeria, Tunisia and Palestine | Gizah, Egypt | Tunisia. | Grenada and Almeria | South Africa. | Ukrain (Former USSR) | Chandbudruk, -Dist. Ahmadnagar, MS, India | Jalna, Tq. and Dist. Jalna M.S., India. |

1. **Conclusion:**

Taking into consideration the above mentioned significant morphological variations, it seems

necessary to represent the present cestode as a new species. Therefore, the name *Diplopylidium alii*, n. sp., is proposed.

**References:**

1. Beddard, F. E. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. *Proc. Zool. Soc. London* **83**, 4–36 (1913).

2. Skrjabin, K. I. Progynopylidium nölleri nov. gem., nov. spec., ein neuer Bandwurm der Katze. [Progynopylidium nölleri nov. gen., nov. spec., a new tapeworm of the cat] [in German]. Berl. *Tierärztl. Wschr.* **40**, 420–422 (1924).

3. Parona, C. Elmintologia sarda. Contribuzione allo studio dei vermi parassiti in animali di Sardegna. [Helminthology of Sardinia. Contribution to the study of parasitic worms in animals of Sardinia]. *Sitzungsberichte der Preuss. Akad. der Wissenschaften, Phys. -Mathematische Klasse [Transactions Prussian Acad. Sci. Physic -Mathemathic Class] [in Ger.* **24**, 275-384. (1887).

4. Witenberg, G. On the cestode subfamily Dipylidiinae Stiles. *Zeitschrift Parasitenk* **4**, 542-584. (1932).

5. Diamare, V. Note su cestodi [remarks on cestodes]. *Boll. Soc. Natur. Napoli [Bulletin Soc. Nat. Naples] [in Ital.* **7**, 9–13 (1893).

6. Lühe, M. Beiträge zur Helmintenfauna der Berberei [Contributions to th helminth fauna of Barbery]. *Sitzungsberichte der Preuss. Akad. der Wissenschaften, Phys. -Mathematische Klasse* **2**, 619–628 (1898).

7. Lopez-Neyra, C. R. Considerations sur le genre Dipylidium Leuckart. [Considerations about the genus Dipylidium] (In French). *Bull Soc Pathol Exot* **20**, 434 – 449 (1927).

8. Hughes, R. C., Baker, J. R. & Dawson, C. B. The Tapeworms of Reptiles. Part I. *Am. Midl. Nat.* **25**, 454 (1941).

9. Lopez-Neyra, C. R. Recherches sur le genre Dipylidium, avec description de quatre espéces nouvelles [Invetigations of the genus Dipylidium, with description of four new species] [in French]. *Bull. Soc. Pathol. Exot.* **21**, 239–253 (1928).

10. Joyeux, C. & Baer, J.-G. Cestodes. Faune de France. *P. Lechevalier Fils, Paris, Fr.* **30**, 613 (1936).

11. López-Neyra, C. R. Los parásitos y sus nosias. *Arbor* **2**, 27 (1944).

12. Lopez-Neyra, C. R. & Munoz Medina, J. M. Dipylidium quinquecoronatum nov. sp., parasite intestinal del gato domestic. [Dipylidium quinquecoronatum nov. sp., intestinal parasite of the domestic cat]. *Bol. Real Soc. Espan. Hist. Nat.* **21**, 421-426. (1921).

13. Matevosjan, E. M. Osnovyj cestodologii tom 3. Dilepidoidea - lentočnyje gel’minty domašnich i dikich životnych [Essentials of Cestodology. Dilepidoidea. in *cestode helminths of farm and wild animals] [in Russian]. Moskva, Nauka.* 687 (1963).

14. Popov, P. Sur le dévelopmenty de Diplopylidium skrjabini n.sp. [On the development of Diplopylidium skrjabini n.sp.] [in French]. *Ann. Parasitol.* **13**, 322–326 (1935).

15. Diamare, V. Di un nuovo cestode del gen. Dipylidium. *Boll. Soc. natur. Napoli, I. s.* **6**, 46–48 (1892).

16. Parrot, L. & Joyeux, C. Le cysticercoides de Tarentola mauritanica L. et les tenias du chat [The cysticercoids of Tarentola mauritanica L. and the taenias of the cat] [in French]. *Bull. Soc. Pathol. Exot.* **13**, 687-695. (1920).

17. Hungerbüler, M. Studien zu Gyrocotyle und Cestoden [Study of gyrocotyle and cestodes] [in German]. *Denkschr. Med.-Naturwissensch. Ges. Jena* **26**, 127–152 (1910).

18. Yamaguti, S. *Systema Helminthum. Vol. II. The Cestodes of Vertebrates.* (Inter Science Publishers, 1959).

19. Velikanov, V. P. Diplopylidium polyacantha sp. n. (Cestoda, Dipylidiidae) – novaja cestoda plotojadnych. *Vestn. Zool.* **1**, 20-24. (1982).

20. Shinde, G. B., Pardeshi, K. S. & Andhare, V. V. On a new species of the genus Diplopylidium (Cestoda: Dipylidiidae) at Udgir, Dist. Latur, M.S., India. *Riv. Parassitol.* **11**, 53–57 (1994).

21. Patil, S. R. & Shinde, G. B. On a new species of the genus Diplopylidium Beddard, 1913 (Cestoda: Dipylidiidae) from Canis familiaris, at Bhadol Dist. Kolhabur, Maharashtra State, India. *Riv. Parassitol.* **14**, 53-57. (1997).

22. Shinde, G. W. & Pawar, S. B. A new species Diplopylidium aurangabadensis n.sp. (Eucestoda: Dipylidiidae) from Felis domesticus at Aurangabad, India. *Uttar Pradesh J. Zool.* 269–270 (2001).

23. Chavan, S. P., Pawar, S. B. & Garad, V. B. A new species Diplopylidium shindei (Eucestoda: Dipylidiidae) from Canis familiaris at Parbhani, MS India. *Riv. Parassitol.* **64**, 55–58 (2003).

24. Shinde, G. B., Bhosale, S. J. & Bhagwan, H. K. Diplopylidium parvatiae sp. nov. (Cestoda: Dilepididae) from Felis chaus in India. *Riv. Parassitol.* **21**, 115–118 (2004).

25. Patil, S. R., Patil, S. S. & Jadhav, B. V. A new species of genus Diplopylidium Beddard, 1913 (Cestode: Dipylididae) from Paradoxurus hermaphrodites, at Kodoli, dist. Kolhapur (M.S.). *Nat. J. Life Sci.* **4**, 89–92 (2007).

26. Sawakar, B. W. An occurrence of new tapeworm Diplopylidium murtizapurensis n. sp. from the intestine of the cat, Felis domesticus at Murtizapur, Maharashtra. *Intern. J. Sci. Res.* 390–391.

27. Suryawanshi, S. G., Mhaske, D. K., Bhagwan, H. K. & Shinde, G. B. On a new species of the genus Diplopylidium (Eucestoda: Dilepididae) from Felis chaus at Chande Budruk, (MS) India. *Asian J. Anim. Sci.* **5**, 212–214 (2010).

28. Rolf, K. S. Cestodes of the genera Diplopylidium and Joyeuxiella (Eucestoda: Dipylidiiae) – a review of historical data, species inventory and geographical distribution. *Sci Parasitol* **21**, 1–17 (2020).

29. Wardle, R. A., McLeod, J. A. & Radinovsky, S. *Advances in the Zoology of Tapeworms, 1950- 1970*. *Univ. of Minnesota Press, Minneapolis.* (1974).