Preliminary observations on the metrical variation of *Helladotherium duvernoyi* and *Bohlinia attica*

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Introduction

Helladotherium duvernoyi and *Bohlinia attica* are two of the most common Late Miocene giraffid species found in the Greco-Afganian faunal province. Although these two species have been comprehensively studied (Bohlin 1926, Geraads 1974) a lot of material from Pikermi, their type locality, remains unknown and distributed in various museum collections.

In order to improve our knowledge for the variation of these taxa we have studied the old collections from Pikermi stored in the Athens Museum (AMPG), and in the natural history museums of Paris (MNHNP) and London (NHML). Moreover, we have included some giraffid specimens recently collected from Kerassia (Euboea).

For the purposes of this paper we have chosen a short bone, the astragalus, and a long bone the metatarsal.

Results and Discussion

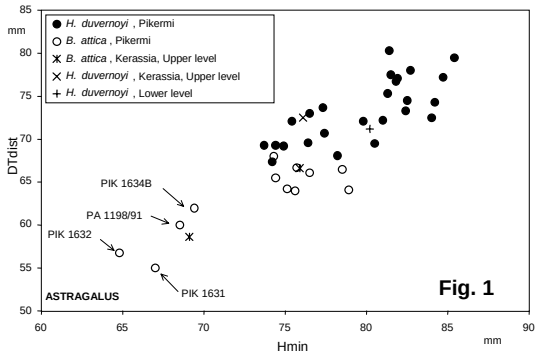
The first indications (Tables 1-2) from the study of these bones suggest that the metatarsal of *H. duvernoyi* exhibits small variation in length. However, the variation of the transverse and anteroposterior diameters is notable. The variation in the astragalus of *H. duvernoyi* is evident but less pronounced for most parameters. The scatter diagrams (Figures 1-4) for both elements are not homogenous but show tendencies for separation into two groups, which probably corresponds to sexual dimorphism.

The few available Kerassia specimens of *H. duvernoyi* are not different in dimensions from the Pikermi specimens. The specimens from the lower fossiliferous level of Kerassia are slightly larger than those from the upper fossiliferous level. Nevertheless, the size of some incomplete specimens from the upper fossiliferous level, not included in this study (metacarpals), is close to the upper range of the Pikermi material. Thus, these observable slight differences in size most likely are not related to differences in geological age, but probably reflect the small number of available specimens. The dimensions of the postcranial material of *H. duvernoyi* from Nikiti 2 (Kostopoulos *et al*. 1996) are not different from the Pikermi sample except from some slightly larger specimens.

As in *H.* duvernoyi, *B. attica* from Pikermi exhibits also evident variation in some parameters (Tables 1-2). Moreover, in the scatter diagrams we observe also tendencies for separation into two groups (Figures 1-4). Although, the specimens from Kerassia (upper level) are inadequate in number, the astragalus of *B. attica*, at least, follows a similar pattern (Figures 1-2).

	H. duvernoyi, Pikermi				*B. attica*, Pikermi			
	MIN	**MEAN (N)**	**MAX**	**% RANGE**	**MIN**	**MEAN (N)**	**MAX**	**% RANGE**
1 (Hlat)	99.3	109.2 (22)	114.2	15.0	87.7	97.7 (9)	103.4	17.9
2 (Hmin)	73.7	79.9 (26)	85.4	15.9	64.8	73.2 (12)	78.9	21.8
3 (Hmed)	87.2	95.0 (27)	102.8	17.9	76.5	83.8 (12)	89.6	17.1
4 (DTdist)	67.4	73.3 (26)	80.3	19.1	55.0	63.2 (12)	68.0	23.6
5 (DAPmed)	58.5	65.3 (26)	73.8	26.2	46.5	55.8 (12)	61.1	31.4
2/1	69.8	73.1 (22)	76.3	9.4	73.9	75.9 (9)	77.1	4.3
2/3	80.7	83.9 (25)	86.8	7.6	84.7	87.3 (12)	90.0	6.2
3/1	83.3	87.0 (22)	90.8	9.1	84.5	87.2 (9)	88.8	5.0
4/1	61.0	67.4 (22)	70.7	16.0	62.4	65.9 (9)	70.2	12.4
4/2	86.3	92.0 (25)	98.6	14.3	81.2	86.4 (12)	91.5	12.7
4/3	71.1	77.2 (26)	85.0	19.6	71.4	75.4 (12)	79.1	10.7
5/1	55.8	60.0 (20)	62.9	12.7	54.8	57.9 (9)	63.1	15.0
5/2	76.4	81.9 (24)	87.9	15.1	69.4	76.1 (12)	82.2	15.2
5/3	62.2	68.6 (25)	75.1	20.7	60.3	66.5 (12)	71.7	13.2
5/4	80.5	89.0 (24)	101.8	26.5	83.1	88.1 (12)	94.1	13.2

Table 1. Measurements and statistical data for the astragalus of *H. duvernoyi* and *B. attica* from Pikermi. (1: Greatest height of the astragalus measured laterally; 2: Minimum height of the astragalus; 3: Height of the astragalus measured medially; 4: Transverse diameter of the distal part; 5: Medial anteroposterior diameter; %Range: indicates the percentage difference of the maximum from the minimum value).



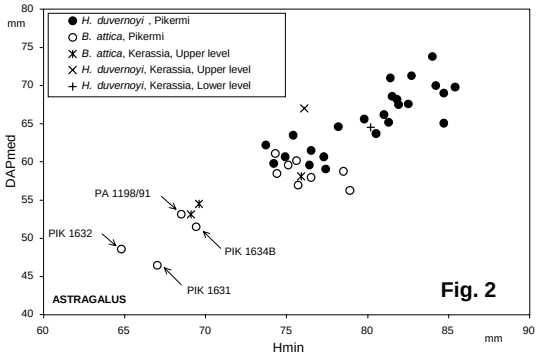


Figure 1. Scatter diagram (Hmin vs DTdist) of the astragalus in *H. duvernoyi* and *B. attica* from Pikermi and Kerassia.

Figure 2. Scatter diagram (Hmin vs DAPmed) of the astragalus in *H. duvernoyi* and *B. attica* from Pikermi and Kerassia.

Among the *B. attica* sample from Pikermi, especially important are some small-sized articulated specimens (AMPG PA 1193-1198/91) including the almost complete tarsus (missing the calcaneus), the metatarsal (missing the distal epiphysis) and the incomplete tibia. The dimensions of these specimens are not different from some small-sized specimens stored in the MNHNP Pikermi collection related by Gaudry (1862-67) to Wagner´s *Camelopardalis speciosa* and also referred by Geraads (1974) as *Bohlinia* sp.

The small sized metatarsal PA 1193/91 is broken slightly above the distal epiphysis and is laterally compressed, mainly on its proximal end. Its DTdia, which measures 40 mm, is not particularly smaller from larger specimens of *B. attica* (Table 2). Its preserved length is 580 mm and its estimated length is about 620 mm. The larger metatarsal of *B. attica* measures 695 mm in length and thus, it cannot be larger than 20% from PA 1193/91. Such differences are not considered particularly important.

Observations in the Field Museum of Natural History of Chicago (FMNH) show that in extant adult *G. camelopardalis tippelskirchi* the male individuals can be markedly larger than the females (Table 3). The length of the metatarsal can be about 21% larger in the males than in the females, and the DTdia can be higher than 40%. This indicates that the observed size variation in *B. attica* from Pikermi can be explained by sexual dimorphism. Another explanation could be the presence of juvenile individuals. Such a case, however, is not very probable since in the MNHNP Pikermi collection there are distal metapodial parts with fused epiphyses, but slender.

	H. duvernoyi, Pikermi				*B. attica*, Pikermi			
	MIN	**MEAN (N)**	**MAX**	**% RANGE**	**MIN**	**MEAN (N)**	**MAX**	**% RANGE**
1 (Lmax)	430.0	451.9 (20)	469.3	9.1	642.3	668.7 (2)	695.0	8.2
2 (DTpr)	75.3	85.2 (21)	93.3	23.9	77.7	75.1 (3)	80.8	4.0
3 (DTprart)	69.7	79.4 (19)	86.6	24.2	72.0	73.4 (2)	74.8	3.9
4 (DAPpr)	78.7	89.0 (19)	94.8	20.5	69.9	73.9 (5)	78.0	11.6
5 (DAPprart)	70.7	80.3 (19)	87.4	23.6	64.2	65.8 (3)	68.8	7.2
6 (DTdia)	46.9	52.8 (19)	60.0	27.9	40.0	45.1 (5)	49.7	24.3
7 (DAPdia)	51.5	58.4 (19)	64.5	25.2	45.8	51.1 (6)	55.1	20.3
8 (DTdist)	80.9	88.9 (19)	96.5	19.3	64.7	70.4 (3)	74.3	14.8
9 (DAPdistlat)	47.7	52.6 (20)	56.8	19.1	42.8	46.2 (2)	49.5	15.7
2/1	17.0	18.7 (18)	20.6	21.2	11.4	12.0 (2)	12.6	10.8
8/1	18.0	19.7 (19)	21.2	18.1	10.4	11.0 (2)	11.6	11.4
6/1	10.3	11.6 (15)	12.6	21.7	7.2	7.2 (2)	7.3	2.3
6/7	79.8	91.1 (17)	100.0	25.3	80.3	87.0 (5)	92.9	15.7
2/4	87.9	95.8 (18)	102.7	16.9	101.2	105.3 (3)	109.2	7.9
9/8	54.3	59.2 (19)	67.3	24.1	66.2	66.4 (2)	66.6	0.7

Table 2. Measurements and statistical data for the metatarsal of *H. duvernoyi* and *B. attica* from Pikermi. (1: Maximum length; 2: Maximum transverse diameter of the proximal end; 3: Transverse articular width of the proximal end; 4: Maximum antero-posterior diameter of the proximal end; 5: Anteroposterior articular diameter of the proximal end; 6: Transverse diameter in the middle of the diaphysis; 7: Anteroposterior diameter in the middle of the diaphysis; 8: Maximum transverse diameter of the distal end; 9: Anteroposterior diameter of the distal lateral trochlea; %Range: indicates the percentage difference of the maximum from the minimum value)

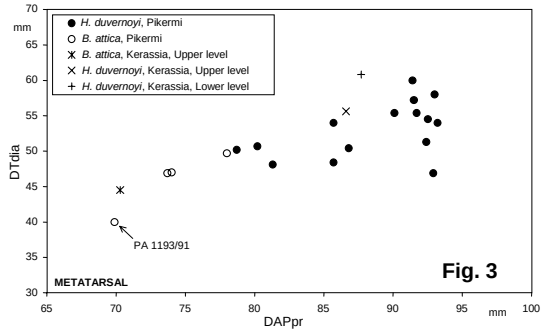


Figure 3. Scatter diagram (DAPpr vs DTdia) of the metatarsal in *H. duvernoyi* and *B. attica* from Pikermi and Kerassia.

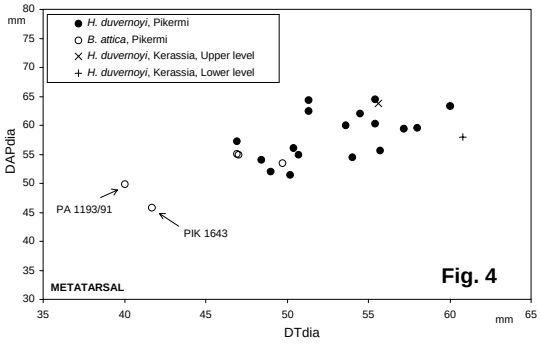


Figure 4. Scatter diagram (DTdia vs DAP-dia) of the metatarsal in *H. duvernoyi* from Pikermi and Kerassia and *B. attica* from Pikermi.

	G. camelopardalis tippelskirchi	
	male (N=1)	female (N=2)
Lmax	750.0	620.0-700.0
DTdia	61.2	42.9-46.2

Table 3. Measurements for the metatarsals of extant adult *G. camelopardalis tippelskirchi* from the FMNH of Chicago collections.

Conclusions

This preliminary study on the metrical variation of the postcranial material of *H. duvernoyi* and *B. attica* from Pikermi shows that there is strong evidence for the presence of two size groups in both taxa. This pattern, in *H. duvernoyi* concerns mainly some of the transverse and anter-oposterior diameters. The same tendency can be noticed in *B. attica*. Currently, due to the insufficient sample of complete long bones of *B. attica*, we don't know if such a pattern is also identifiable or not on the length parameters. We consider that such a pattern possibly reflects

sexual dimorphism, with the male individuals of both species being more strongly built than the females.

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