

Soft body impression of the hand in *Archaeopteryx*

While studying the wing feathers of the famous Berlin *Archaeopteryx*, we noticed that the hand and arm are surrounded by a natural depression. Impressions of the calamus of various feathers extend into this depression, indicating that it formed before the decay and loss of at least some of the associated soft anatomy surrounding the skeleton. The lithographic limestone normally shows little surface relief and few alternative explanations are available for depressions along an articulated and largely undisturbed skeleton. We wondered if this really was a soft tissue impression and whether we could recover a cast that would help us understand the hand in the oldest known bird. Our attempt (Figure 1) revealed an essentially

avian hand with the outer and middle fingers united nearly to the claw and a long posterior patagium extending along the margin of the hand and arm. Heilmann¹ postulated a similar structure probably because the deep follicles that anchor long primary feathers require this morphology. We think that the middle and outer fingers were also united in other forms with long primary feathers (*Micro-raptor*, *Caudipteryx*)^{2,3}, although they, *Archaeopteryx* and *Confuciusornis* are routinely restored with separated fingers²⁻⁴.

There are also indications of an avian prepatagium (Figure 2). The presence of a prepatagium constrains the extension of the forearm so that the junction between

the humerus and the radius and ulna usually reflects the pattern of avian wing-folding in bird fossils. It is significant that all of the fossil skeletons of *Archaeopteryx* preserve an avian folding pattern on at least one wing. We conclude that the soft structure of the *Archaeopteryx* wing, like the feathers⁵, was essentially modern in conformation. Such a hand lacks significant grasping capabilities and was of little use for capturing the small prey, indicated by the size and shape of the teeth and mouth. We suppose that the fingers and claws were used primarily for climbing⁶. The primary feathers at the tip of the wing would have run under the outer finger to attach to the middle finger. The outer finger was probably



Figure 1. Cast of depression surrounding skeleton of right hand and forearm of the Berlin *Archaeopteryx*. The form of soft tissue surrounding the bones is clearly delineated and closely similar to the condition found in modern birds.

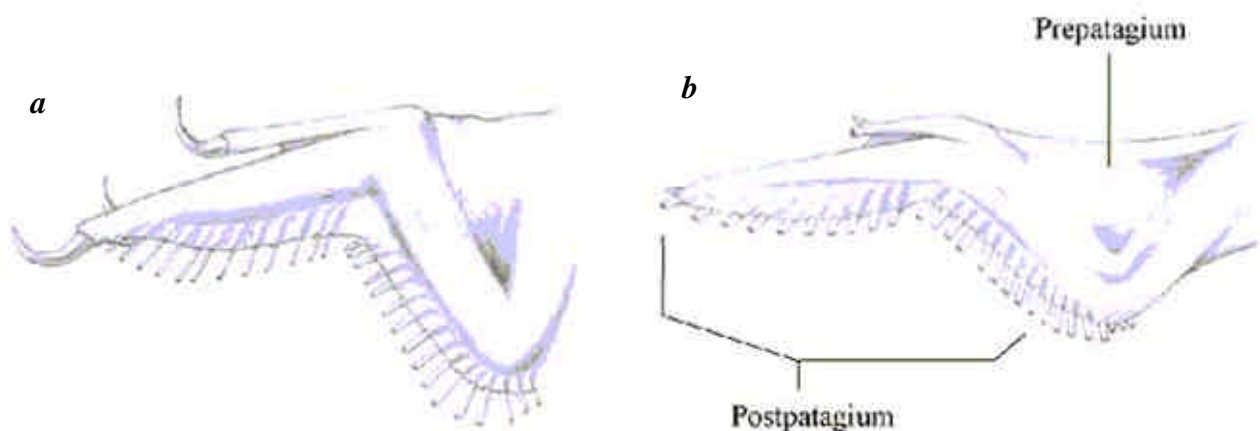


Figure 2. *a*, Restoration of right hand and forearm of the Berlin *Archaeopteryx* based on the Figure 1. *b*, Hand and forearm of a modern duck for comparison (modified from Lucas and Stettenheim⁷, figure 38).

above the middle and free for a short distance. This may explain why the outer finger crosses the middle finger in the preserved specimens. In more advanced birds, the outer finger is greatly reduced.

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Green mussel *Perna viridis*, a new host for the pea crab *Pinnotheres placunae* along the Malabar coast, Kerala

The pea crab *Pinnotheres placunae*, parasitizing the green mussel *Perna viridis*, along the Malabar coast is reported. The infested mussels suffered significant reductions in shell size and live weight.

Along the Elathoor beach, 10 km away (north) from Calicut city, green mussels, commonly called *Mytilus (Perna viridis)*, were collected by local fishermen. The presence of one small crab within the mantle cavity of the mussel was recorded. The crab was less than a centimetre in size; some of them carried a number of eggs. With help from Central Marine Fisheries Research Institute, Calicut, it was identified as pea crab, *Pinnotheres placunae* (Figure 1).

There are many species of pea crabs, all grouped together by taxonomists to the family Pinnotheridae. The pea crab has a carapace width ranging from 10 to 12 mm. The genus is recognized by the third pair

of walking legs, which is longer than the other pairs, and the dactyli of 3rd and 4th walking legs being larger than 1st and 2nd walking legs.

The occurrence of the pea crab *Pinnotheres* in oysters, clams, ascidians, holothurians and brachiopods has been reported from different parts of the world^{1–3}. Silas and Alagarwami⁴ studied their occurrence and effects of their infestation on the backwater clam, *Metrix casta* from the southwest coast of India.

Elathoor beach possesses extensive rocky area particularly laterite stones, which form a suitable substratum for the growth of host species *P. viridis*.

From July 2003 to June 2004, 100 mussels were collected regularly every month from local fishermen, and the shells were opened and checked for the presence of pea crab. When the pea crab was present, its measurements were taken. The mussels were preserved in 5% formalin (diluted using

sea water). Weight of each mussel was noted to the nearest milligram. The preserved mussels were opened; both the location and number of pea crabs on either side of the viscera were recorded, along with damages, if any, caused to the soft parts of the host and the wet weight of the mussel (excluding the shell) was also taken after pressing it gently with blotting paper to remove excess moisture. The length and breadth of the carapace of crabs were also taken. Once removed from the host, the crabs were preserved in 70% alcohol.

A total number of 1200 mussels were examined and it was found that 74 were infested with crabs of a single species *P. placunae*. Majority were found near the exhalent siphon within the mantle cavity.

A male crab can be distinguished from the female from the dimensions (mm) of carapace and cheliped (Table 1).

In females, carapace and chelipeds are larger than those of males. In a mature

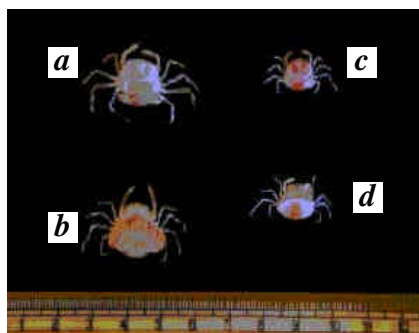


Figure 1. *Pinnotheres placunae*. **a**, Female – dorsal view; **b**, Oviparous female – ventral view; **c**, Male – dorsal view; **d**, Male – ventral view.

Table 1. Distinguishing features between male and female crabs

Body part	Male	Female
Carapace		
Length of carapace (mm)	6.25	8
Breadth of carapace (mm)	7.25	11.25
Length divided by breadth of carapace	0.86	0.70
Cheliped		
Length of dactylus (mm)	1.625	2
Length of upper boarder of palm (mm)	2.5	3.125
Greatest width of palm (mm)	1.625	1.75
Ratio of length of dactylus : length of upper boarder of palm	0.65	0.64
Ratio of length of dactylus : width of palm	1	1.14