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La Lagune

Et Aristote inventa la science…

Flammarion

Glossaires

- glossaire technique
- les espèces mentionnées

Appendices

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A
AI Technical Glossary

aithêr	ether
anô	above
antithesis	opposite position (anatomy)
analogon	*analogue*
aphrodisiazomenai	highly sexed
aphros	foam
apodeixis	demonstration
archê	origin/principle
aristeros	left
atomon eidos	indivisible form
automatos	spontaneous/self-moving things
balanos	glans
basileia	queen
basileus	king
bios	lifestyle
chelidonias	swallow wind
chôrion	amniotic sac
delphys	uterine body
Dêmiourgos	Creator
dexios	right
diaphora/diaphorai	difference/pl. (in some feature)
dynamis	potentiality, potency, power
echinos	omasum/hedgehog/sea urchin/wide-mouthed jar
eidos/eidê	form/pl.
eikôs mythos/eikotes mythoi	likely or plausible story
emprosthen	before
entelecheia	actuality
epagôgê	induction
epamphoterizein	dualizing
epistêmê	knowledge

euripos	strait
geêron	earth
genos/genê	kind/pl.
gêras	old age
gês entera	guts of the earth
gonê	semen
hippomanousi	nymphomaniac
historia tês physeôs	The study of nature
historiai peri ton zoon	*Historia animalium* [*Enquiries into Animals*]
holon	whole
hylê	matter
hystera	uterus/female reproductive organs
katamênia	menses
katô	below
kekryphalos	reticulum
keratia	uterine horns
kinêsis/kinêseis	movement/pl.
kotylêdons	cotyledons/caruncles
limnothalassa	lagoon, lit. lake sea
logos	definition, essence
lysis	relapse/mutation
mathematikê	mathematics
megalê koilia	rumen
metabolê	transformation
mêtra	cervix
mixis	compound
mues	muscles
mythos	story
mytis	cephalopod 'heart' (i.e. its digestive gland)
neuron/neura	sinews/pl.
nous	reason
oikoumenê	known world
onta	things
opisthen	behind
organon	instrument/too/organ
ornithiai anemoi	bird winds
ousia/ousiai	substance, entity/pl.
pepeiramenoi	to have tried or tested something
peri physeos	on nature

phainomena	appearances
phantasia	mental representation
phantasma	mental images
physeos	nature
physikê epistêmê	natural science, lit. study of nature
physikos	one who understands nature
physiologos/physiologoi	one who studies nature/pl.
pneuma	pneuma
polis	city state
politikê epistêmê	political science
prôton stoicheion	first element
psychê	soul
sarx	flesh (i.e. muscles)
soma	body
sperma	seed
stoma	mouth
stomachos	oesophagus
sungenis	kindred
symmetria	proportion
symphyton pneuma	connate breath
synthesis	mixture, agglomeration of parts
ta aphrodisia	sexual intercourse
technika	skilled activities
telos	end
theologikê	theology
theos	god
thesis	position (anatomy)
to agathon	the good
to hou heneka	that for the sake of which
trophê	nutrition/way of life
zôiê	livelihood

A2
Animal Kinds Mentioned

> Considering this mass of valuable information, one must particularly regret that the author [Aristotle] did not suspect that the nomenclature of his time might become opaque, and that he therefore took no precautions to ensure that the species he discusses are recognizable. This is the general defect of the ancient naturalists; one is almost obliged to guess the identities behind the names they used; the often changing tradition induces error; thus it is by arduous deduction, and bringing together features scattered among authors, that one gets a positive result for some species; but we are condemned to remain ignorant of the majority of them.
>
> Georges Cuvier and Achille Valenciennes,
> *Histoire naturelle des poissons* (1828–49)

The task of identifying Aristotle's animals started around 1256 when Albert Magnus began to assemble his *De animalibus* based, in part, on *Historia animalium*. Zoologically minded classicists and classically minded zoologists have been at it ever since. They have had mixed success. Aristotle's descriptions of his animals are often so thin as to defy identification. However, other classical texts using the same or similar names provide clues, as do the vernacular names used by modern Aegean and Adriatic fishermen and hunters. Biogeography helps too. Or one can simply go to the Lagoon to see what's there. One scholar who did so plausibly identified Aristotle's *kobios* as any of three species of goby and his *phycis* as the blenny, *Parablennius sanguinolentus*.*

Although generations of scholars have laboured to identify Aristotle's animals, there is no recent, comprehensive list of them. For this reason I tabulate the 230-odd Aristotelian animal kinds mentioned in this book, along with my best guess as to what they are. Scholars have varied in their

* Tipton (2006).

willingness to pin Aristotelian kinds down to Linnaean species. Some are enthusiastic while others think that it can hardly be done at all. I have taken the middle road. After all, when Aristotle says *hippos*, he must mean *Equus caballus*, that is a horse – at least when he doesn't mean the *hippos* crab or the *hippos* woodpecker. When, however, he says *kephalos* we are less sure. He certainly means a grey mullet since that's what they're still called in Greece today, but he could mean any or all of *Mullus cephalus* (flathead grey mullet), *Chelon labrosus* (thicklip grey mullet), *Oedalechilus labeo* (boxlip mullet), *Liza saliens* (leaping mullet), *Liza aurata* (golden grey mullet) or *Liza ramada* (thinlip grey mullet), all of which are found in Greek waters and are notoriously hard to tell apart.* Moreover, Aristotle mentions at least four different fishes that are plausibly grey mullets, so it's likely that he, and fishermen, distinguished at least some of the six modern nominal species. But which of Aristotle's grey mullets correspond to ours must probably always remain a mystery.

There is also a trap for the unwary. Linnaeus and other early taxonomists often gave their European species classical names on the basis of ancient descriptions. Sometimes they were right to do so. Linnaeus' *Chamaeleo chamaeleon chamaeleon* – the European chameleon – is certainly Aristotle's *chamaíleo* since it's the only lizard that answers to his detailed description.† Sometimes, however, they were on much less certain ground. Linnaeus thought that Aristotle's *rinobatos* was the guitarshark so he called the guitarshark *Rhinobatos rhinobatos*; and since both the fish and what Aristotle says about it are interesting, it's nice to think that that is what it actually is, but we can't be sure since he doesn't say much.

My list is based on several editions of *Historia animalium* and *The Parts of Animals*‡ as well as monographs on ancient animals.§ I have tried to make ambiguity plain. In general, large mammals can be identified to modern species; birds to genus or not at all (*Historia animalium* contains a swathe of strange, possibly Egyptian or Babylonian, bird names); fish to species,

* Koutsogiannopoulos (2010).

† True, the African chameleon, *Chamaeleo africanus*, occurs in Pylos in the Peloponnese, but that's thought to be a Roman introduction. Why the Romans should have carried chameleons around the Mediterranean basin is hard to say.

‡ *HA*: Cresswell and Schneider (1862), Peck (1965), Peck (1970) and Balme (1991). *PA*: Ogle (1882), Lennox (2001a) and Kullmann (2007).

§ Kitchell (2014) on mammals and some other animals, Thompson (1895) and Arnott (2007) on birds, Thompson (1947) on fishes, Davies and Kathirithamy (1986) on insects, Scharfenberg (2001) on cephalopods and Voultsiadou and Vafidis (2007) on marine invertebrates.

genus or family depending on their prominence, uniqueness and depth of description; insects mostly to family or order; marine invertebrates anywhere from species to phylum. For a few of Aristotle's creatures, however, we can say little more than that they are probably animals and that they live in the sea.

English name	Aristotle's name	Linnaean name
ANIMALS	**ZôA**	**METAZOA**
BLOODED ANIMALS	*ENHAIMA*	VERTEBRATA
man (humans)	*anthrôpos*	*Homo sapiens*
live-bearing tetrapods	***zoiôtoka tetrapoda***	**Mammalia (most)**
ass, Asian wild (onager)	*onos agrios*	*Equus hemionus*
ass, Asian wild (onager)?	*hêmionos**	*Equus hemionus?*
ass, domestic (donkey)	*onos*	*Equus africanus asinus*
baboon, hamadryas	*kynokephalos*	*Papio hamadryas*
bear, Eurasian brown	*arktos*	*Ursus arctos arctos*
beaver, Eurasian	*kastôr*	*Castor fiber*
bison, European	*bonassos*	*Bison bonasus*
camel, Arabian (dromedary)	*kamêlos Arabia*	*Camelus dromedarius*
camel, Bactrian	*kamêlos Baktrianê*	*Camelus bactrianus*
cat	*ailouros*	*Felis silvestrus cattus*
cattle	*bous*	*Bos primigenius*
cattle, wild	*tauros*	*Bos primigenius* (*auroch*)
deer, red?	*elaphos*	*Cervus elephas?*
deer, roe	*prox*	*Capreolus capreolus*
dog	*kyôn*	*Canis lupus familiaris*
dog, Molossian	*kyôn* xxxxxxxxxxxx	*Canis lupus familiaris* (mastiff)
dog, Laconian	*kyôn* xxxxxxxxxxxx	*Canis lupus familiaris* (hound)
dog, Indian	*kyôn Indikos*	*Canis lupus familiaris* (Indian pariah dog?)
dormouse	*eleios*	Gliridae
elephant, Asian†	*elephas*	*Elaphas maximus*
fox	*alôpêx*	*Vulpes vulpes*
gazelle, dorcas	*dorkas*	*Gazella dorcas*
unknown bovid	*pardion*	Bovidae
giraffe?	*hippardion*	*Giraffa camelopardis?*

* Aristotle also uses this term for the regular mule; its relationship to the onager is unclear; see Kitchell (2014).

† Aristotle does not say where his elephant was seen; it is most likely the Asian elephant on the basis of its association with Alexander's expeditions alone.

goat, ram	*tragos*	*Capra aegagrus*
goat, ram	*chimaira*	*Capra aegagrus*
goat, ewe	*aïx*	*Capra aegagrus*
hare, European	*dasypous*	*Lepus europaeus*
hare, European	*lagôs*	*Lepus europaeus*
hartebeest	*boubalis*	*Alcelaphus buselaphus*
hedgehog, northern	*echinos*	*Erinaceus roumanicus*
hippopotamus	*hippos potamios*	*Hippopotamus amphibius*
horse	*hippos*	*Equus caballus*
hyena, striped*	*hyaina*	*Hyaena hyaena*
hyena, striped	*glanos*	*Hyaena hyaena*
hyena, striped	*trochos*	*Hyaena hyaena*
jackal, golden?	*thôs*†	*Canis aureus*?
jerboa	*dipous*‡	Dipodidae
leopard	*pardalos*	*Panthera pardus*
lion, Asian	*leôn*	*Panthera leo persica*
lynx, Eurasian	*lynx*	*Lynx lynx*
macaque, Barbary	*pithêkos*	*Macaca sylvanus*
macaque, Rhesus?§	*kêbos*	*Macaca mulatta*?
mole, Mediterranean¶	*aspalax*	*Talpa caeca*

* Beginning with Watson (1877), there's a long, and incorrect, consensus that Aristotle's *glanos/hyena* is the spotted hyena, *Crocuta crocuta*, but the mane alone identifies it as the striped hyena *Hyena hyena*. Furthermore, Aristotle's description of its genitals doesn't fit the massively masculinized genitalia of *Crocuta* females. I assume that the *trochos* is the same animal, but that's less certain; see Funk (2012). Kitchell (2014) says that Oppian distinguished the spotted and striped hyena, so perhaps the former wasn't entirely unknown to the ancients.

† Kitchell (2014) points out that this animal has a bewildering number of identifications. It may be jackal, civet or some sort of viverrid.

‡ This is the ancient Greek name for the animal. Aristotle does not actually use it, but just speaks of mice with long legs or that walk on their hind legs – clearly the jerboa.

§ Aristotle mentions three non-human primates: the *kynocephalos*, *pithêkos* and *kêbos* (excluding the textually dubious *choreopithêkos* of *HA* 503a19). The *kynocephalos* is certainly the Egyptian baboon, *Papio hamadryas*, since it has a doglike face and no tail; the *pithêkos* is said to have a short tail and so is likely the Barbary macaque, *Macaca sylvanus*. The *kêbos* is said to have a tail, but the tailed African *Cercopithecus* are all sub-Saharan, so perhaps it's a report of the Asian rhesus macaque, *Macaca mulatta*, from Alexander's expedition. See Kullmann (2007) p. 709 and Kitchell (2014).

¶ The *aspalax* could be the naked mole rat, *Spalax*, of Asia Minor or the Mediterranean mole, *Talpa caeca*. Both *Spalax* and *T. caeca* are blind and have eyes covered in skin, but the latter seems more biogeographically plausible. (*T. europea*, the common European mole, is found north of the Alps and is disqualified by its small, but externally visible, eyes.)

mongoose, Egyptian	*ichneumôn*	*Herpestes ichneumon*
mouse	*mus*	*Mus* sp.
mouse, field	*arouraios mus*	*Apodemus* sp.
mouse, spiny	*echinees*	*Acomys* sp.
mule	*oreus*	*Equus africanus asinus* (m) × *Equus caballus* (f)
mule	*hêmionos*	*Equus africanus asinus* (m) × *Equus caballus* (f)
mule (hinny)	*ginnos*	*Equus caballus* (m) × *Equus africanus asinus* (f)
nilgai	*hippelaphos*	*Boselaphus tragocamelus*
oryx	*oryx*	*Oryx* sp.
otter	*enhydris*	*Lutra lutra*
pig	*hys*	*Sus scrofa domesticus*
porcupine, crested	*hystrix*	*Hystrix cristata*
rhinoceros, Indian*	*onos Indíkos*	*Rhinoceros unicornis*
seal, monk	*phôkê*	*Monachus monachus*
sheep	*krios*	*Ovis aries*
sheep	*oïs*	*Ovis aries*
sheep	*probaton*	*Ovis aries*
shrew	*mygalê*	Soricidae
tiger	*martichôras*	*Panthera tigris*
marten	*iktis*	*Martes* sp.
weasel	*galê*	*Mustela* sp.
wolf, grey	*lykos*	*Canis lupus*
cetaceans	***kêtôdeis***	**Cetacea**
dolphin	*delphis*†	*Delphinidae*
whale	*phalaina*	Odontoceti

Thompson (1910) *n. HA* 491b30 favours *T. caeca* simply because it rather more common than *Spalax* in the areas that Aristotle knew personally; see Kullmann (2007) p. 457.

* The *onos Indíkos* is generally thought to be an Indian rhinoceros (Ogle 1882 p. 190, Thompson 1910 *n.* 499b10). Lones (1912) p. 255, looking at its feet, disagrees. Lones is right to say that the rhinoceros has three toes and the *onos indicus* one, but the rhino's central toe is much larger than the others and so could easily be mistaken for a hoof.

† Likely the bottlenose dolphin, *Tursiops truncatus*, but Aristotle does not distinguish the several Delphinid spp. found in the Aegean.

birds	*ornis*	Aves
bee-eater, European	*merops*	*Merops apiaster*
blackbird	*kottyphos*	*Turdus merula*
bustard, great	*ôtis*	*Otis tarda*
chaffinch	*spiza*	*Fringilla coelebs*
chicken	*alektôr*	*Gallus domesticus*
chicken, Adrianic	*adrianikê*	*Gallus domesticus*
cormorant, great	*korax*	*Phalacrocorax carbo*
crane, Eurasian	*geranos*	*Grus grus*
crow, hooded	*korônê*	*Corvus corone*
cuckoo	*kokkyx*	*Cuculus* sp.
dove, turtle	*trygôn*	*Streptopelia turtur*
duck, teal?	*boskas*	*Anas crekka?*
eagle	*aietos*	*Aquila*
flamingo, greater*	*phoinikopteros*	*Phoenicopterus ruber*
nightjar	*aigothêlas*	*Caprimulgus europaeus*
goldcrest	*tyrannos*	*Regulus regulus*
goose	*chên*	*Branta* sp.
grebe, great crested	*kolymbis*	*Podiceps cristatus*
vulture	*aigypios*	*Aegypius* sp.
hawk	*hierax*	Accipitridae, small
heron	*pellos*	*Ardea* sp.
hoopoe, Eurasian	*epops*	*Upapa epops*
ibis†	*ibis*	Threskiornithidae
jay, Eurasian	*kissa*	*Garrulus glandarius*
kestrel	*kenrichis*	*Falco* sp. *tinnunculus* or *F. naumanni*
kingfisher	*alkyôn*‡	*Alcedo atthis*
kite	*iktinos*	*Milvus* sp.
lark	*korydalos*	Alaudidae
nuthatch, rock	*kyanos*	*Sitta neumayer*
ostrich	*strouthos Libykos*	*Struthio camelus*

* Not mentioned by Aristotle, but now very common in Kalloni. The only references to a flamingo (or what might be one) in ancient Greece are in Aristophanes' *Birds*, 273 and Heliodorus.

† Either the glossy ibis, *Plegadis falcinellus*, found in Greece (Kalloni) or the sacred ibis, *Threskiornis aethiopicus*, found in Egypt.

‡ May also refer to a species of tern.

owl, little*	*glaux*	*Athene noctua*
owl, Ural?	*aigôlios*	*Strix uralensis?*
partridge	*perdix*	*Alectoris* or *Perdix*
pelican, Dalmatian	*pelekan*	*Pelecanus crispus*
pigeon	*peristera*	*Columba* sp.
pigeon, wood	*phatta*	*Columba palumbus*
quail	*ortyx*	*Coturnix vulgaris*
raven	*korax*	*Corvus corax*
seagull	*laros*	Laridae
sparrow	*strouthos*	*Passer* sp.
stilt, black-winged	*krex*†	*Himantopus himantopus*
stork, white	*pelargos*	*Ciconia ciconia*
swallow	*chelidôn*	*Hirundo rustica*
tit	*aigithallos*	*Parus* sp.
tit, coal	*melankoryphos*	*Parus ater*
turtle dove	*trygôn*	*Streptopelia turtur*
woodpecker‡	*dryokolaptês*	*Dendrocopus* sp.
woodpecker	*hippos*	*Dendrocopus* sp.
woodpecker	*pipô*	*Dendrocopus* sp.
woodpecker, green	*keleos*	*Picus viridis*
wren	*trochilos*	*Troglodytes troglodytes*

* Athena's owl. The ancient proverb 'bringing owls to Athens' is the Greek equivalent of bringing coals to Newcastle.

† Traditionally identified as the corncrake, *Crex crex*; but this is dubious and the *krex* is mentioned by Aristotle as a long-legged waterbird with a short hind toe and a quarrelsome disposition (Thompson 1895 p. 103; Arnott 2007 p. 120) which does not fit the corncrake well, but does the black-winged stilt.

‡ *Dryokolaptês* is a general name for woodpecker (literally 'tree-pecker'). Aristotle (*HA* 593a5, *HA* 614b10) speaks of at least four kinds of woodpecker as well as the *hippos*, some of which are easily identified, others not. When he refers to a small woodpecker with reddish speckles he must mean *Dendrocopus minor* since it is the only small woodpecker found in Greece that answers to the description. When he refers to a larger woodpecker that nests in olive trees he must mean *D. medius* since it is the only species to do so; interestingly it does so only in Lesvos (Filios Akreotis, pers. comm.). When he refers vaguely to a 'larger' species he could mean one of the three large *Dendrocopus*: the white-backed, *D. leucotos*; Syrian, *D. syriacus* or greater spotted, *D. major*, which are all about the same size (8–10 inches). *Hippos* may be a copyist's error for *pipô*. In addition to these Aristotle refers to a green woodpecker, clearly *Picus viridis*. See Thompson (1895) and Arnott (2007).

egg-laying tetrapods	***ôiotoka tetrapoda***	**Reptilia* + Amphibia**
chameleon	*chamaileôn*	*Chamaeleo chamaeleon chamaeleon*
crocodile	*krokodeilos potamios*	*Crocodylus niloticus*
gecko, Turkish?	*askalabôtês*	*Hemidactylus turcicus?*
lizard	*sauros*	Lacertidae
tortoise	*chelônê*	*Testudo* sp.
terrapin	*emys*	*Mauremys rivulata?*
turtle	*chelônê thallatia*	Cheloniidae
snakes	***opheis***	***Serpentes***
snake, water	*hydros*	*Natrix tessalata?*
snake, large	*drakon*	Serpentes
Ottoman viper	*echidna*	*Vipera xanthina*
fishes	***icthys***	**Chondrichthyes + Osteichthyes**
blenny, rusty?	*phycis*†	*Parablennius sanguinolentus?*
blotched picarel	*maenis*	*Spicara maena*
catfish, Aristotle's	*glanis*	*Silurus aristotelis*
comber	*channos*	*Serranus cabrilla*
comber, painted	*perkê*	*Serranus scriba*
eel, European	*enchelys*	*Anguilla anguilla*
goby	*kôbios*	*Gobius cobitis?*
'goby, white'	*leukos kôbios*	unknown
gurnard	*kokkis*	Triglidae
gurnard	*lyra*	Triglidae
John Dory	*chalkeus*	*Zeus faber*
mullet, grey	*chelôn*	Mugilidae
mullet, grey	*kephalos*	Mugilidae
mullet, grey	*kestreys*	Mugilidae
mullet, grey	*myxinos*	Mugilidae
mullet, red	*trigle*	*Mullus* sp.

* Not a valid taxon; now the Sauropsida, which includes birds as a clade of dinosaurs.
† The *phycis* been variously identified as a goby (*Gobius niger*), a species of wrasse (e.g. *Symphodus ocellatus*).
Thompson 1910 *n. HA* 567b18, Thompson (1947) pp. 276–8, or a blenny (*Parablennius sanguinolentus*), Tipton (2006). It's hard to know since all of these are found in Kalloni or its surrounds and the description is vague and may be confused with other fishes.

parrotfish	*skaros*	*Sparisoma cretense*
pipefish	*belonê*	*Syngnathus* sp.
salema	*salpê*	*Sarpa salpa*
scorpionfish	*skorpaina*	*Scorpaena scrofa*
sea bass, European	*labrax*	*Dicentrarchus labrax*
sea bream, annular	*sparos*	*Diplodus annularis*
sea bream, gilthead	*chrysophrys**	*Sparus aurata*
sea bream, pandora	*erythrinos*	*Pagellus erythrinus*
sea bream, striped	*mormyros*	*Lithognathus mormyrus*
sea bream, white	*sargos*	*Diplodus sargus sargus*
sea perch, swallowtail	*anthias*	*Anthias anthias*
shad	*thritta*	*Alosa* sp. or another Clupeid
smelt, sand	*atherinê*	*Antherina presbyter*
tuna, blue fin	*thynnos*	*Thunnus thynnus*
unknown	*korakinos*	unknown
unknown, sardine-like	*chalcis*	Clupeidae
unknown, sardine-like	*membras*	Clupeidae
unknown, sardine-like	*trichis*	Clupeidae
cartilagenous fishes	***selachê***	**Chondrichthyes**
angelshark	*rhine*	*Squatina squatina*
dogfish, smooth	*leios galeos*	*Mustelus mustelus*
dogfish, spiny	*akanthias galeos*	*Squalus acanthias*
dogfish, spotted	*skylion*	*Scyliorhinus* sp.
frogfish†	*batrachos*	*Lophius piscatoris*
guitarfish?	*rhinobatos*	*Rhinobatos rhinobatos?*
ray, torpedo	*narkê*	*Torpedo torpedo*
skate or ray	*batos/batis*	Rajiformes
shark	*galeos*	Galeomorphi + Squalomorphi
unclassified blooded animals		
tadpole or eft	*kordylos*	Amphibia
bat	*nykteris*	Microchiroptera
fruit bat, Egyptian (flying fox)	*alôpêx*	*Rousettus aegyptiacus*

* Sometimes confused with *Chrysophrys auratus*, an Indo-Pacific fish, due to a complicated history of synonomy.
† *Contra* Aristotle, the frogfish is not a cartilagenous fish.

BLOODLESS ANIMALS	ANHAIMA	Invertebrata*
'soft-shells'	***malakostraka***	**Crustacea (most)**
crab	*karkinos*	Brachyura
crab, fan mussel	*pinnophylax*	*Nepinnotheres pinnotheres*
crab, ghost	*hippos*	*Ocypode cursor*
lobster	*astakos*	*Homarus gammarus*
shrimp	*karis*	Nantantia + Stomapoda
shrimp, fan mussel	*pinnophylax*	*Pontonia pinnophylax* or similar spp.
spiny lobster	*karabos*	*Palinurus elephas*
shrimp, mantis	*krangôn*	*Squilla mantis*
'soft-bodies'	***malakia***	**Cephalopoda**
cuttlefish	*sêpia*	*Sepia officinalis*
octopus, common	*polypodon megiston genos*	*Octopus vulgaris*
octopus, musky	*boilitaina*	*Eledone moschata*
octopus, musky	*heledônê*	*Eledone moschata*
octopus, musky	*ozolis*	*Eledone moschata*
paper nautilus	*nautilos polypous*	*Argonauta argo*
squid, European	*teuthis*	*Loligo vulgaris*
squid, sagittal	*teuthos*	*Todarodes sagittatus*
'hard-shells'	***ostrakoderma***	**Gastropoda + Bivalvia + Echinozoa + Ascidiacea + Cirripedia**
cockle	*konchos rhabdotos*	
	trachyostrakos	Cardidae
limpet	*lepas*	*Patella* sp.
mussel, fan	*pinna*	*Pinna nobilis*
oyster	*limnostreon*	*Ostrea* sp.
razorfish?†	*sôlên*	Solenidae?
scallop	*kteis*	Pectinidae

* Not a valid taxon.

† Aristotle says the *sôlên* can't live if torn off a rock. Elsewhere, however, he says that it is free living and might be able to hear. One of these must be wrong. The *sôlên* is traditionally identified as the razor-clam (*Solenidae*), a sand-burrower, and among the most active and perceptive of all bivalves.

sea urchin, edible	*esthiomenon echinos*	*Paracentrotus lividus*
sea urchin, long-spine	*echinos genos mikron*	*Cidaris cidaris*
sea squirt	*têthyon*	Ascidiacea
snail, murex	*porphyra*	*Haustellum brandaris*
snail, murex	*porphyra*	*Hexaplex trunculus*
snail, trumpet	*kēryx*	*Charonia variegata*
snail, turban	*nêreitês*	*Monodonta* sp.?
'divisibles'	***entoma***	**Insecta + Chelicerata + Myriapoda**
ant	*myrmêx*	Formicidae
bee, honey (drone)	*kêphên*	*Apis mellifera*
bee, honey (queen, lit. king)	*basileus*	*Apis mellifera*
bee, honey (queen, lit. leader)	*hêgemôn*	*Apis mellifera*
bee, honey (worker)	*melissa*	*Apis mellifera*
beetle, dung	*kantharos*	Scarabaeoidea
butterfly	*psychê*	Lepidoptera
centipede or millipede	*ioulos*	Myriapoda
cicada	*tettix*	*Cicada* sp.
clothes moth	*sês*	*Tinea* sp.
cockchafer	*mêlolonthê*	*Geotrupes* sp.
flea	*psylla*	Siphonaptera
fly	*myia*	Diptera
fly, horse	*myôps*	*Tabanus* sp.
grasshopper	*akris*	Acrididae
locust	*attelabos*	Acrididae
louse	*phtheir*	Phthiraptera
mayfly	*ephêmeron*	Ephemeroptera
pseudoscorpion	*to en tois bibliois gignonmenon skorpoiodes**	*Chelifer cancroides*
scorpion	*skorpios*	*Scorpio* sp.
spider	*arachnê*	Araneae
tick	*kynoroestes*	*Ixodes ricinus*
wasp	*sphêx*	Vespidae
wasp, hunting	*anthrênê*	Vespidae

* Literally 'scorpion found within books'.

wasp, fig	*psên*	*Blastophaga psenes*
wasp, parasitoid	*kentrinês*	*Philotrypesis caricae?*

unclassified

fish louse	*ostros o tôn thynnon*	*Caligus* sp.
hermit crab	*karkinion*	Paguroidea
jellyfish?	*pneumôn**	Scyphozoa?
red coral	*korallion*	*Corallium rubrum*
sea anemone	*knidê*	Actinaria
sea anemone	*akalêphê*	Actinaria
sea cucumber?	*holothourion*†	Holothuria?
sponge	*spongos*	Dictyoceratida
sponge, black Ircinia	*aplysias*	*Sarcotragus muscarum?*
starfish	*astêr*	Asteroidea
worm	*helminthes*	Plathyhelminthes, Annelida, Nematoda etc.
worm, tape	*plateion genos helmithos*	*Taenia* sp.
worm, nematode ('round')	*strongyleion*	*Ascaris?*
worm, unknown	*askarid*	unknown

* Voultsiadou and Vafidis (2007) identify this as the dead man's fingers sponge, *Alcyonium palmatum*. That's plausible too.
† Voultsiadou and Vafidis (2007) identify this as the soft coral, *Veretillum cynomorium*. That's plausible too.

B
Technical Appendices

Here I present some of Aristotle's data and models as he might were he writing now: in tables and diagrams. Such devices are not in principle un-Aristotelian since he clearly used abstract models to explain biological phenomena at least occasionally – for example, when he explains animal geometry in PA or perception and movement in MA.* Nevertheless, my justification for using them does not rest upon such examples, for my purpose is not to reproduce his methods, but rather to understand the strengths and weaknesses of his data and his explanations. The absence of data tables in his work is particularly painful: he can take a book (e.g. HA VI on avian life history) to explain patterns that would now be summarized in a single table in Nature – and in the Online Supplementary Information at that. In the same way it is also impossible to know whether the heart–lung cycle he gives in JSVM 26 really works as he says it does without building a control model or else a physical analogue – and the first seems a lot easier. Classical philosophers may shy at the resulting tables and diagrams; to them such devices may seem incongruously modern. I would ask them to view them merely as tools analogous to their use of modern symbolic notation to explicate and test the coherence of Aristotle's logic. Scientists will be less fussed; to them, the utility of such devices will seem obvious and they will only wonder how Aristotle got as far as he did using mere words. I would ask them to remember that, although he was smart, he did live a long time ago.

B1. A DATA MATRIX FOR TWELVE ARISTOTELIAN KINDS AND SIX MORPHOLOGICAL FEATURES

This table displays some of the morphological features that Aristotle thinks some animals have. His information is not always correct. For convenience the feature states are first coded as integers. If Aristotle thinks an animal kind has more than one feature state this is indicated with a slash, for example 0/1; intermediate states are indicated as 0.5; no data as 'NA' This table is based on the following sources. **Foot type**: lion, dog, sheep, goat, deer, hippopotamus, horse, mule, pig, HA 499b5.

* Natali (2013) ch. 3.3.

Coding

feature	state	
tooth no.	teeth in upper jaw ≠ teeth in lower jaw	0
	teeth in upper jaw = teeth in lower jaw	1
tooth shape	flat	0
	saw	1
	tusks	2
stomach	simple	0
	complex	1
horns	absent	0
	present	1
feet	solid-hooved	0
	cloven-hoofed	1
	multi-toed	2
astragalus	absent	0
	present	1

Matrix

feature / kind	tooth no.	tooth shape	stomach	horns	feet	astragalus
ox	0	0	1	1	1	1
goat	0	0	1	1	1	1
sheep	0	0	1	1	1	1
deer	0	0	1	1	1	1
camel	0	NA	1	0	1	1
pig	1	2	0	0	1/0	1/0
horse	1	0	0	0	0	0
mule	1	0	0	0	0	0
elephant	NA	0/2	1	0	2	0
lion	1	1	0	0	2	0.5
dog	1	1	0	0	2	0
human	1	1	0	0	2	0

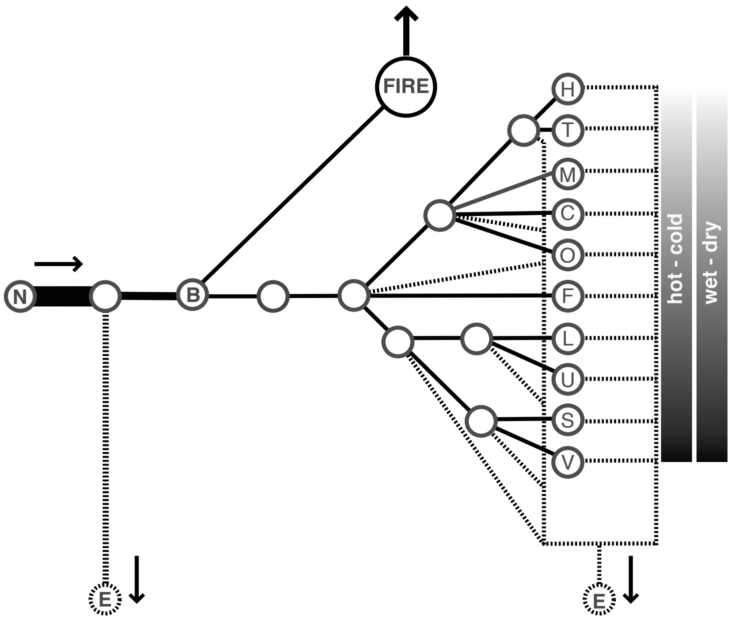
to be resupplied

Astragalus with foot type: lion, pig, man, cloven-hoofed animals, solid-hoofed animals, HA 499b20; human HA 494a15; camel HA 499a20. **Horns with cloven hoofs:** ox, deer, goat HA 499b15. **Tooth number and horns:** horned animals, camels, HA 501a7, HA 499a22. **Tooth type and horns:** pig, lion, dog, horse, ox, HA 501a15; elephant HA 501b30. **Stomach type and horns and tooth number:** HA 495b25; HA 507b30, human HA 495b25. The feature matrix shows a strong association between the various features that Aristotle describes. These associations then become the target of explanations. This table could be expanded to include more kinds and features, but I do not do so since for these either his data are incomplete or he makes little of them.

B2. RESOURCE (TROPHÊ) ACQUISITION AND ALLOCATION PATHWAY FOR A LIVE-BEARING TETRAPOD (A MAMMAL)

This diagram summarizes Aristotle's vision of the metabolic system, how nutrition is taken up, transformed and allocated to its various ends. The arrows represent material flows. Aristotle's 'uniform parts' are roughly equivalent to our tissues except that he is emphatic they have no microscopic structure such as atoms or cells. All uniform parts derive from blood, itself a uniform part. There are two great branches in the network, earthy uniform parts and fatty uniform parts, with flesh being at the terminus of a branch of its own. All reactions produce waste; and all uniform parts are broken down into waste and excreted, giving an open system. Some nutrition goes to fuel the internal fire. The nodes represent specific transformations of nutrient. The supporting statements for network are as follows. **Blood** is the final/universal nutriment: PA 650a34, PA 651a15. **Flesh** is made from the purest nutriment and bones, sinews etc. are residues: GA 744b20. **Flesh** is concocted blood and **fat** is the surplus blood left over from this: PA 651a 20. **Fat** is concocted blood: PA 651a21. **Fat** can be soft or hard (suet or lard): PA 651a20. **Semen** comes from blood, specifically from the part that forms fat: PA 651b10; GA 726a5. **Marrow** is partially concocted blood: PA 651b20. **Hoofs, horns and teeth** are related to **bone**: PA 655b1, PA 663a27. **Bones** and **marrow** are made from a common precursor: PA 652a10. **Cartilage** and **bone** are fundamentally the same thing: PA 655a27. Deposits from the bladder and gut are **residues** of nourishment: PA 653b10. **Bile** is a residue of nourishment: PA 677a10.*

* See Leroi (2010) for further details.



LEGEND

N nutrition

B blood

H hooves, hair, nails

T teeth

M marrow

C cartilage

O bone

F flesh

L lard

U suet

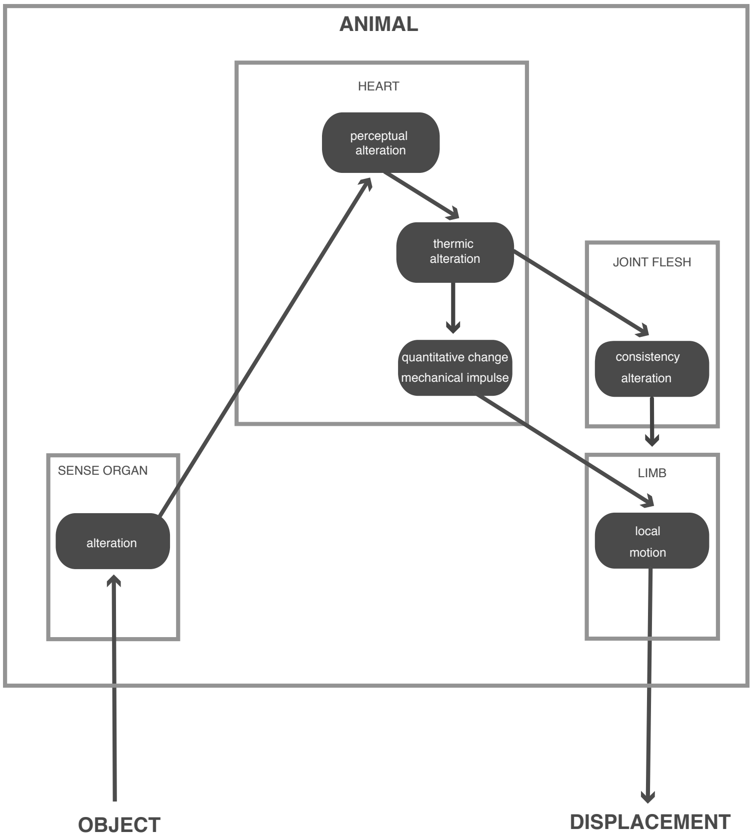
S semen

V vaginal secretions, menstrual fluid, milk

E excreta: urine, bile, faeces

B3. THE CIOM MODEL OF PERCEPTION AND ACTION

This diagram represents the Centralized Incoming Outgoing Motions model of how Aristotle supposes animals transmit perceptual information from the peripheral sense organs to the sensorium (the heart), how this information is integrated with respect to the animal's goals and how it is transformed into movement in its limbs via the action of pneuma and the mechanical workings of the sinews.* The arrows represent causal relations.



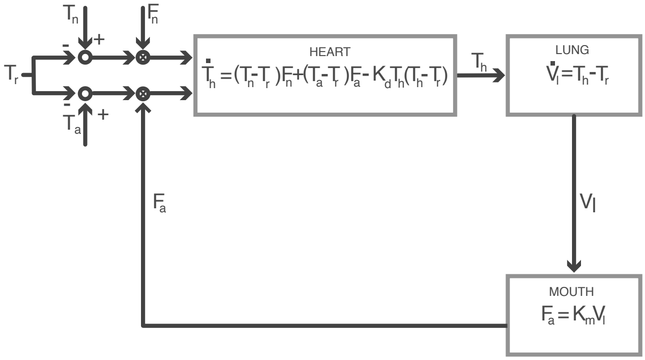
* GREGORIC and CORCILIUS (2013).

B4. CONTROL DIAGRAM OF ARISTOTLE'S HEART–LUNG THERMOREGULATORY CYCLE

This is the simplest of many possible models that could describe the heart–lung cycle that Aristotle sketches in JSVM 26.* The arrows represent control relations. To make Aristotle's model work we need various assumptions explicit that he does not. Here, we assume that the animal has an ideal 'reference' temperature, T_r. The goal of the system is to maintain the temperature of the heart, T_h, at that temperature. The system works in the following way. Nutrition enters the heart and is concocted. The temperature of the nutrition (now blood), T_n, rises above the reference temperature. If that increase in temperature is sufficient to exceed heat loss due to diffusion (see below), it will increase the heart temperature, T_h. Since lung volume is a function of the difference between T_h and T_r, lung volume increases. This results in an increase in the rate of air flow through the mouth, F_a. Since air temperature, T_a, is lower than the reference temperature, heart temperature declines and the lung contracts. The result is a negative feedback control system. Note that we allow for the constant loss of some fraction of heart heat by diffusion, perhaps via the brain that, in Aristotle's view, acts as a radiator. This will tend to damp the system making it less sensitive to increases in T_n and gives an equilibrium at T_r. This system will work only if air temperature is lower than the ideal reference temperature. If, however, T_a ❧ T_r, then no amount of air will reduce T_h, the negative feedback loop will become an unstable positive feedback loop, and the animal's lungs will stay permanently open or permanently closed, either way extinguishing the fire (due to excess cold or consumption of all the nutrient), thus resulting in death. As described here, the system will tend to a stable dynamic equilibrium rather like a thermostat. However, if additional delays or non-linearities are included, it will produce the oscillatory behaviour that Aristotle supposed explained the lung's movements. The model was produced with the kind help of David Angeli, Electrical Systems Control Group, Imperial College London.

[C204]

* King (2001) pp. 126–9.



LEGEND

T_r	reference temperature
T_h	heart temperature
T_n	nutrient temperature
T_a	air temperature
F_n	nutrient flow
F_a	air flow
V_l	lung volume
K_d	heat diffusion constant
K_m	air intake constant
◉	sensor
⊗	multiplier
+	positive regulation
-	negative regulation

b5. aristotle's life-history data: live-bearing tetrapods and birds

These tables summarize Aristotle's life-history data. His data are a bit more complex than the tables suggest and, again, are not always correct. Since Aristotle does not have descriptive statistics, he often says that something is 'generally' the case; if so, that is the value I give. If he gives a range, I report a median but ignore exceptional cases. When he says that he is uncertain (e.g. about the great lifespan of the elephant or the short lifespan of the sparrow) I have indicated this with a u. In some cases Aristotle does not explicitly say that a particular kind has some value for a given life-history variable, but just speaks generally about the megista genos – for example, 'very few birds propagate in their first year'. In such cases, I have indicated the value as belonging to all kinds within that greater kind unless noted otherwise; but in cases where he does not say explicitly that a value applies to a megista genos I have not assumed it. For example, he probably knows that most large live-bearing tetrapods (mammals) have one brood per year, but he does not say so. The exception to this rule is body size. Aristotle never reports quantitative data for body size, nor even whether an animal is big or small except in the context of a functional explanation. From such explanations, however, it's clear that he thinks a human or an ostrich is 'large', a pig or a chicken is 'medium sized' and a cat or sparrow is 'small' relative to the megista genos to which each belongs; I have filled in appropriate body sizes accordingly. Most of these data come from HA V and VI; data on embryonic perfection come from GA IV. Aristotle argues correctly that multi-toed animals (fox, bear, lion, dog, wolf, jackal etc.) have imperfect young; solid- and split-hoofed animals (cow, horse) have perfect young. The pig is an oddity, being split-hoofed and having relatively perfect offspring. Among the birds, Aristotle names ravens, jays, sparrows, swallows, ring doves, turtle doves and pigeons as having imperfect neonates – but doesn't name any perfect ones. He probably bases his generalizations on more data than he reports.

[C205a, b]

zoiōtoka tetrapoda live-bearing tetrapods

feature kind	S	M (years)	L (years)	C (per year)	N	G (months)	P
mouse	*S*				many		
hare	*S*				4		*I/P*
cat	*S*		6 l		<8		*I*
mongoose	*S*		6 l		<8		*I*
jackal	*S*				4		*I*
goat	*M*	1	8 l		1.5	5	*P*
sheep	*M*	1	10 l		<4	5	*P*
pig	*M*	0.75	15 l		<20	4	*P*
wolf	*M*				<8	2	*I*
dog	*M*	0.9			<8	2	*I*
leopard	*M*		12 l		4		*I*
lion	*M*		5 l	1	4		*I*
bear	*L*				3.5	1/9	*I*
horse	*L*	3	37 l	1	1.5	11	*P*
ass	*L*	3	30 l	1		12	*P*
cattle	*L*	1.5	15 l		1.5	9	*P*
deer	*L*				1.5		*P*
camel	*L*	3	>50 l		1	10	*P*
human	*L*	<21	40f/70m rl		1	9.5	
elephant	*L*	7	250*u* l	1	1	30	

LEGEND

S adult body size: *L*arge, *M*edium, *S*mall

M age at maturity

L lifespan: l simple lifespan, rl reproductive lifespan

C broods per year

N brood size

G gestation time

P relative perfection: *P*erfect, *I*mperfect *ornis* birds

feature kind	S	M (years)	L (years)	C (per year)	N	G (months)	P
coal tit	*S*	>1*		1	>20		
tit	*S*	>1		1	many		
sparrow	*S*	>1	1*u* l	1	many		*I*
kingfisher	*S*	0.3		1	5		
bee-eater	*S*	>1		1	6.5		*I*
swallow	*S*	>1		2			
nightjar	*S*	>1		1	<3		
cuckoo	*S*	>1		1	<2		
jay	*S*	>1		1	many		*I*
pigeon	*S*	0.5	8 l	10	<3	0.5	*I*
turtle dove	*S*	0.4*u*	8 l	≤2	<3		*I*
wood pigeon	*S*	0.4*u*	30 l	≤2	<3		*I*
hen	*M*	>1		many	many	1.7	
partridge	*M*	>1	>16 l	1	many	0.6	
raven	*M*	>1		1	4	0.6	*I*
kite	*M*	>1		1	2	0.6	
hawk	*M*	>1		1			
kestral	*M*	>1		1	4		
Ural owl?	*M*	>1		1	4		
peacock	*L*	3	25 l	1	<12	1	
goose	*L*	>1		1		1	
bustard	*L*	>1		1		1	
vulture	*L*	>1		1	2		
eagle	*L*	>1		1	3	1	
ostrich	*L*	>1			many		

LEGEND

S adult body size: *L*arge, *M*edium, *S*mall

M age at maturity

L lifespan: l simple lifespan, rl reproductive lifespan

C clutches per year

N clutch size

G time to hatching *or* fledging

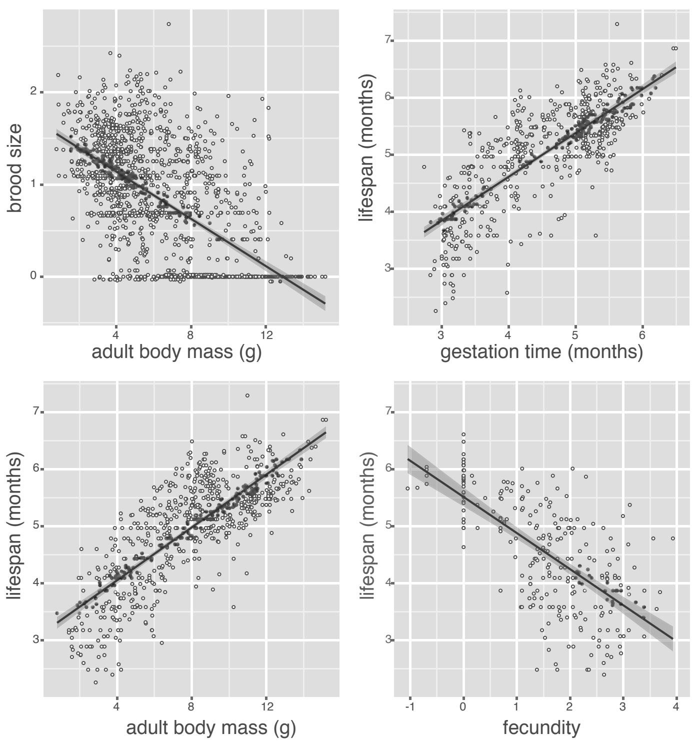
P relative perfection: *P*erfect, *I*mperfect

* When Aristotle says that 'very few birds propagate in their first year' he certainly means that they propagate in their second, that is, the following breeding season, typically spring.

B6. RELATIONSHIPS AMONG SOME LIFE-HISTORY FEATURES REPORTED BY ARISTOTLE, ILLUSTRATED USING MODERN DATA

In GA IV and LBV, Aristotle claims that various life-history features are associated with each other in certain ways. His claims are correct at least for placental mammals. Below, I illustrate four of these associations using data from the panTHERIA database of mammalian life history.* I exclude Orders not seen by Aristotle (e.g. Marsupialia) or else excluded from his tetrapods (Chiroptera, Cetacea), and then model the log-transformed data using linear regression. Four of Aristotle's claimed relationships are shown: brood size and adult body size (negative), gestation time and longevity (positive), adult body size and longevity (positive) and fecundity and adult body size (negative). Much more sophisticated analyses of this sort have often been published.† They usually aim to take various confounding effects into account and so reduce, but hardly eliminate, the difficulty of inferring causal relations from comparative data.

[C206]



* JONES et al. (2009).

† For example, MILLAR and ZAMMUTO (1983), DERRICKSON (1992), STARCK and RICKLEFS (1998), BIELBY et al. (2007).