

Pollux on Bronze Casting: A New Look at κάναβος

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THE TECHNICAL TERM κάναβος is used in a variety of contexts. It appears in late lexicographical entries concerning bronze casting, in fifth-century B.C. tragic and comic fragments, and in passages describing the human body. In many cases, κάναβος is used metaphorically and, as a result, it has been variously interpreted and translated. It will be seen, however, to have a consistent meaning that can be applied to all of its uses.

The only full definition of κάναβος is given in the second century by Pollux, in a description of bronze casting. τὸ μὲν δὴ ξύλον ᾧ περιπλάττουσι τὸν πηλὸν οἱ κοροπλάθοι, κάναβος καλεῖται· ὅθεν καὶ Στράτις ἐν τῷ Κινησίᾳ τὸν Σαννυρίωνα διὰ τὴν ἰσχνότητα κάναβον καλεῖ· αὐτὸ δὲ τὸ πῆλινον, ὃ περιείληφε τὰ πλασθέντα κήρινα, ἃ κατὰ τὴν τοῦ πυρὸς προσφορὰν τήκεται καὶ πολλὰ ἐκείνῳ τρυπήματα ἐναπολείπεται, λίγδος καλεῖται· ὅθεν καὶ Σοφοκλῆς ἔφη ἐν Αἰχμαλώτισιν·

ἀσπὶς μὲν ἡμῆ λίγδος ὡς πυκνομματεῖ.¹

¹ Poll. *Onom.* 10.189. The text is Bethe's except for λίγδος (twice) and πυκνομματεῖ, for which I follow Bekker, Nauck and Bentley respectively: the first λίγδος Bekker; μίλιγδος *codd.*, *acc.* Bethe; ἡμῆ λίγδος Nauck, Pearson; ἡμίλιγδος *codd.* The word λίγδος is problematic. It appears elsewhere, meaning 'mortar' (Nic. *Theor.* 589, 618; also as ἕγδισ Sol. 39, Damocr. *ap. Gal.* 14.130, Dsc. 5.89, AP 9.642 [Agath.], or ἕγδη Hdn.Gramm. *Tech.* 2.523, Hippoc. *Mul.* 1.103), or 'lye' (Eust. 1229.27; also as λίγδα Hsch.). The definite article does not make sense in the Sophoclean fragment. μίλιγδος probably < ημιλιγδος through iotacism; the first use of μίλιγδος in this passage may be the result of a scribe's misunderstanding of the Sophoclean fragment. We are left with λίγδος, ἕγδισ, ἕγδη; only the first is suitable here. In the passage in Pollux, the meaning of λίγδος is clearly 'mould'. πυκνομματεῖ Bentley, *acc.* Bekker, Pearson; πυκνώματι, πυκνὸν πατεῖ *codd.*; πύκνωμά τι Bethe. πυκνομματεῖ agrees with Pollux's paraphrase and is an acceptable emendation if the phrase is taken to refer to a mould used in bronze casting.

Pollux uses κάναβος in one other passage (7.164), which does not necessarily refer to bronze casting: περὶ δὲ οἱ τοὺς πηλίνους πλάττοντες τὸν πηλὸν περιθέντες πλάττουσι, τοῦτο τὸ ξυλήφιον κάναβος καλεῖται . . . "The wooden stick around which the sculptors model the clay is called the κάναβος." πηλίνοιοι, πηλίθοιοι, πλίνοιοι, πίθοιοι *codd.* Only πηλίνοιοι makes sense in this context, and the other forms may be explained as corruptions of πηλίνοιοι.

“The wood around which the image-makers² work the clay (core) is called the *κάναβος*. Hence Strattis in (his work) *Kinesias* calls Sannyrion a *κάναβος* because of his thinness. But the clay that surrounds the modeled wax, which melts by the application of fire and leaves behind many holes in the clay, is called the mould (*λίγδος*). Hence Sophocles said in (his work) *The Captives*: ‘My shield is like a mould, for it is full of holes.’”³

Pollux mentions a clay mould, modeled wax, and the melting of the wax, three major characteristics of bronze casting by the direct lost-wax method;⁴ it is clearly this process to which he refers. Briefly, this is the process of bronze casting in which a wax model is formed over a clay core and covered by a mould. Baking burns out the wax, destroying the model; molten metal is then poured into the hollow left by the burnt-out wax. Only one casting can be made from a model; if the casting fails, the model must be formed again.

The problem in this passage of Pollux is that no earlier literary source refers to the use of wood in the casting process. In fact, a number of Greek bronze statues, such as the Delphi Charioteer⁵ and the Peiraeus Kouros, preserve a metal armature, which is usually regarded as another typical feature of a casting prepared by the direct lost-wax process in both ancient and modern procedure. This framework supports the clay core and the surrounding wax as they are built up to form the figure. But Pollux and two later lexicographers⁶ suggest that wood may be used for an armature.

² *κοροπλάθοι* is commonly used to refer to the makers of terracotta figurines (Pl. *Tht.* 147b; Isoc. 15.2; Lucian, *Lex.* 22), but here it should mean those who practice bronze casting because it is only in this way that the passage is consistent, since clay, wax and fire are all mentioned in connection with the *κοροπλάθοι*. The word may have been used here to describe the technicians involved with bronze casting because of a lack of a more specific term.

³ The statement in Sophocles that a mould is full of holes has been left unexplained by philologists and archaeologists alike. It may very well derive from the following. When the mould is baked, the wax model and the wax rods that form the gate system (pouring channels for the bronze) are burned out. This leaves the mould cavity empty to receive the molten bronze at the pour.

⁴ H. Blümner, *Technologie und Terminologie* IV (Leipzig 1887) 326 n.2, cites this passage and remarks that today the indirect method of casting is known, as well as the direct. C. C. Edgar, *Greek Moulds* (Cairo 1903) xi, refers to Blümner’s remark and suggests that “the Greeks are not likely . . . to have restricted themselves to the one variety of the *cire perdue* method to which the description of Pollux presumably refers.”

⁵ F. Chamoux, *L’Aurige*, *FdeD* IV.5 (Paris 1955) 61.

⁶ Hsch. II p.407 Latte s.v. *κάναβοι*: τὰ ξύλα, περὶ ἃ τὸ πρῶτον οἱ πλάσται τὸν κηρὸν τιθέασιν· ὄθεν καὶ οἱ λεπτοὶ καὶ ἄσαρκοι *κάναβοι* λέγονται, “the wood around which modelers first put

It could perhaps be argued that Pollux confused lost-wax casting with the *sphyrelaton* process of making bronze statuary, which was still known in later antiquity. Here wood probably formed the entire core for cold-hammered sheets of metal (Paus. 3.17.6), as it did also for some *xoanon*-like figures (Paus. 3.19.2, 9.12.4). That Pollux was not thinking of the relatively solid core of a *sphyrelaton* statue, however, is shown by his reference to the analogy between *κάναβος* and a thin man.

If Pollux had not mentioned wax, the passage might be explained as referring to the making of terracotta sculpture, where a wooden core or framework could have been used, since openings are left in a terracotta to allow gases to escape during baking.⁷ But even before firing, the contraction of the drying clay would be impeded by a rigid wooden core and the clay might crack.

No other literary source confirms Pollux's reference to wood, nor is there yet any archaeological evidence for it. An explanation, however, may be found in modern bronze casting. Today wood can be used as an armature for a direct lost-wax casting. (It is not a universal practice, nor is it commonly mentioned in technical handbooks.) A core is built up over the armature and the wax is added. With the core completely enclosing the armature, the burning out of the wood results in a tubular structure that is highly resistant to pressure from outside. An alternative method is to hang the wax directly on the armature and then to pour the core. With the armature and the wax touching, once the wood has burned out, the bronze flows into the space where the armature was, giving the sculpture a form of bronze

the wax, whence thin and fleshless people are called *κάναβοι*"; and *s.v.* *κανάβι(ν)ος κηρός*: *ᾧ χρώνται οἱ ἀνδριαντοποιοὶ πρὸς πλάσιν*, "that which the sculptors use for modeling." Phot. *Lex.* I p.139.15 Porson *s.v.* *κάναβος*: *τὸ πρῶτον τιθέμενον ξύλον ὑπὸ τῶν πλαστῶν· περὶ δὲ τὸν πηλὸν τιθέντες πλάσσουν*, "the wood put first by the modelers, around which they place the clay in modeling." Hesychius omits the clay from the process; Photius restores the clay but omits the wax. Neither lexicographer adds to our knowledge of the process. See also Stephanus, *TGL*³ (1865, rpt. Graz 1954) *s.v.* *κάναβος*.

⁷ Prehistoric terracotta statues of about two-thirds lifesize found in Keos were built up partially with rings of clay like pithoi, but the torso and often the shoulders were formed around wooden posts. These are published only in a preliminary report: J. Caskey, *Hesperia* 35 (1966) 370. Large-scale terracotta sculptures of the archaic and classical periods have been discovered by Ronald S. Stroud and Nancy Bookidis in the Sanctuary of Demeter and Kore on Acrocorinth; see *Hesperia* 34 (1965) 1–24, 37 (1968) 299–330, 38 (1969) 297–310, and 41 (1972) 283–331. For the techniques used to produce terracotta figurines see R. A. Higgins, *Greek Terracottas* (London 1967) 1–3.

armature.⁸ This modern analogy verifies Pollux's reference to a wooden rather than a metal armature in what is the only ancient description of the direct lost-wax process.⁹

The central part of the passage in Pollux does not pose any problems if *κάναβος* is interpreted as an armature. Here Pollux writes that in *Kinesias* Strattis called Sannyrion a *κάναβος* because of his thinness (*ισχρότητα*); there is other ancient authority for Sannyrion's comic thinness, for Aristophanes tells us that Sannyrion, Meletos and *Kinesias* are all exceedingly thin.¹⁰ Sannyrion is hardly a 'block-figure', as Edmonds has suggested,¹¹ but rather so thin as to be skeletal. If *κάναβος* is indeed the term for an armature, then the word immediately suggests the skeletal appearance of a very thin and fleshless man like Sannyrion. An epigram said to have been written by Lucillius in the first century draws the same analogy.

*Αἰγείρου φύλλῳ πεφορημένῳ ἐξ ἀνέμοιο
πληγεῖς Χαιρήμων ὕπτιος ἐξετάθη.
κεῖται δ' ἢ Τιτυῶ ἑναλίγκιος, ἢ πάλι κάμπη,
ἀπλώσας κατὰ γῆς σῶμα τὸ καννάβινον.¹²*

"Hit by a black poplar leaf borne along by the wind, Chairemon fell on his back. He lies (there) like Tityos or like a caterpillar, spreading out his *καννάβινον* body on the ground." The meaning of this epigram has been obscured by difficulties in interpreting *κάναβος*. As a result, Paton, although he translates the end of the last line correctly as "his skeleton body," gives the wrong interpretation to *κάναβος* as the "block around which a sculptor moulds his clay."¹³ Beckby wrongly translates *καννάβινον* as meaning "ein Modellkern so dünn."¹⁴ Neither interpretation is possible, for a skeleton cannot be described as a block, and a clay core is certainly not thin. The meaning of the epigram is instead that Chairemon, like the armature of a statue, is so thin or skeletal that he can be knocked down by a leaf.

⁸ For this information I am grateful to Mr Harvey Moore, a Washington, D.C., bronze sculptor and founder.

⁹ It should be pointed out, however, that ancient bronze casting cannot be reconstructed entirely on the basis of modern practice, primarily because of the different mould materials and the technologically advanced furnaces in use today.

¹⁰ Kock, *CAF* I p.428 fr.149-50.

¹¹ J. M. Edmonds, *The Fragments of Attic Comedy* I (Leiden 1957) 813 [hereafter, EDMONDS].

¹² *Anth.Pal.* XI 107, ed. F. Dübner II (Paris 1872) 304.

¹³ *The Greek Anthology*, ed. W. R. Paton, IV (LCL, London/New York 1918) 123 n.1.

¹⁴ *Anthologia Graeca*, ed. H. Beckby, III (Munich 1958) p.599.

Aristotle uses *κάναβος* in contexts that are not related to bronze casting: twice he employs the word to explain the construction of the animal or human body. The first passage reads: *Ἐκ δὲ τῆς καρδίας αἱ φλέβες διατεταμέναι, καθάπερ οἱ τοὺς κανάβους γράφοντες ἐν τοῖς τοίχοις· τὰ γὰρ μέρη περὶ ταύτας ἐστίν, ἅτε γιγνόμενα ἐκ τούτων.*¹⁵ “From the heart the blood vessels extend, just like the *κάναβοι* that they draw on walls, for the (fleshy) parts surround them because they are formed from them.” Apparently Aristotle envisions the outer parts of the body as surrounding the blood vessels, which form a kind of framework for the outer body. His parallel with *κάναβοι* drawn on walls suggest that the blood vessels are a kind of framework for the body. Arthur Platt, in fact, translates *κάναβοι* here as “anatomical diagrams.”¹⁶ The concept of an anatomical sketch, or of a stick-figure to be filled out, brings to mind the guide lines used in ancient painting,¹⁷ a practice later carried to an extreme in the meticulous nineteenth-century method of painting a figure by drawing the skeleton, covering that with the nude body, and finally painting on top of all this the figure’s clothing. This concept is a direct two-dimensional parallel for the three-dimensional concept of an armature over which a statue is constructed.

Aristotle compares blood vessels to *κάναβοι* a second time: *αἱ μὲν γὰρ φλέβες, ὥσπερ ἐν τοῖς γραφομένοις κανάβοις, τὸ τοῦ σώματος ἔχουσι σχῆμα παντὸς οὕτως ὥστ’ ἐν τοῖς σφόδρα λελεπτυσμένοις πάντα τὸν ὄγκον φαίνεσθαι πλήρη φλεβίων (γίγνεται γὰρ ὁ αὐτὸς τόπος λεπτῶν μὲν ὄντων φλέβια, παχυνθέντων δὲ σάρκες) . . .*¹⁸ “For the blood vessels, just as in the drawn *κάναβοι*, have the form of the whole body, so that in extremely slender people the whole volume of the body seems to be full of blood vessels (the same space in thin people is filled with blood vessels, and in fat people with flesh) . . .” Here *κάναβος* has been explained by Tricot as a sculptor’s sketch.¹⁹ But again, Aristotle seems to see the blood vessels as a kind of framework, which becomes

¹⁵ Arist. *Gen.An.* 743a2 (p.78 ed. H. J. Drossaart Lulofs).

¹⁶ Arist. *Gen.An.* 743a2, *The Works of Aristotle*, edd. J. A. Smith and W. D. Ross, trans. A. Platt, V (Oxford 1962). Similarly, Peck translates *κάναβοι* as ‘skeleton models’ drawn on the wall and writes that “there seems to be no justification for interpreting *κάναβοι* as a mere outline or sketch” (p.219 n.d), meaning that they are something that reveals the interior structure upon which the outlines are based.

¹⁷ See J. V. Noble, *The Techniques of Painted Attic Pottery* (New York 1965) 50 figs. 191–93. For large-scale guide lines see M. Mellink, *AJA* 75 (1971) 252.

¹⁸ Arist. *HA* 515a34ff (I p.186 ed. A. L. Peck).

¹⁹ Arist. *HA* 515a35 (I p.179 ed. J. Tricot).

visible in a thin person whose interior form is not well concealed by flesh.

In another passage, Aristotle is more explicit about the relation of flesh to blood vessels: . . . τὰς φλέβας περὶ ἧς ὡς περὶ ὑπογραφὴν τὸ σῶμα περίκειται τὸ τῶν σαρκῶν,²⁰ “. . . the blood vessels, around which lies the flesh of the body, as around a framework (ὑπογραφή).” The analogy with a framework is still with a drawing or a sketch,²¹ but the passage leaves no doubt that Aristotle sees blood vessels as a framework or armature around which the structure of the body is built up. Aristotle refers to the same kind of framework in all of these passages, whether it is a flat sketch on a wall or a real framework like the armature that is used in bronze casting. It is for this reason that Aristotle is able to draw parallels between the fine lines of blood vessels in a solid body and a drawing on a flat surface.

Aristotle uses one more analogy to explain the way in which the body is built up over a framework, but this time it is a framework of bones rather than of blood vessels. The parallel is drawn with the work of clay modelers. ὥσπερ γὰρ οἱ πλάττοντες ἐκ πηλοῦ ζῶον ἢ τινος ἄλλης ὑγρᾶς συστάσεως ὑφικτᾶσι τῶν στερεῶν τι σωματίων, εἶθ' οὕτω περιπλάττουσι, τὸν αὐτὸν τρόπον ἢ φύσιν δεδημιούργηκεν ἐκ τῶν σαρκῶν τὸ ζῶον. τοῖς μὲν οὖν ἄλλοις ὑπεστὶν ὅσα τοῖς σαρκώδεσι μορίοις . . .²² “Just as the modelers (making) an animal from clay or some other pliant substance place under (it) some solid body and then mould around it, in the same way nature fabricates an animal out of flesh, for with one exception [the stomach] bones are under the fleshy parts . . .” Although the general picture of pliant flesh being moulded around a firm support of bones is clear, it is not easy to discover the process with which Aristotle is drawing an analogy. His mention of clay seems to suggest the manufacture of terracotta figurines, but, so far as we know, ancient terracottas did not contain truly skeleton-like supports.²³ In bronze casting, as we have seen, a clay core is modeled

²⁰ Arist. *Gen.An.* 764b29ff (p.137 ed. Drossaert Lulofs).

²¹ ὑπογραφὴ must here mean a sketch or diagram of the sort that illustrated the tactics of Asclepiodotus (11.7). Similar uses of the word appear in Arist. *Mete.* 346a32, *Int.* 22a22, *HA* 510a30; and in *Pl. Resp.* 504D, 548D, *Leg.* 737D.

²² Arist. *Part.An.* 654b29ff (p.41 ed. B. Langkavel).

²³ A terracotta figurine was made from a mould (*matrix*) taken from a solid clay model (*patrix*). Since this solid model was removed from the terracotta mould after the impression was made, it could not have served as a support for it. Monumental terracottas are also hollow, and were apparently not made over any form of core except for the early

around an armature which, if it is not wood, may remain in the center of the bronze statue. But Aristotle's language does not imply that the animal made of clay or some other plastic material is a preliminary step rather than a final product, and a skeleton-like armature is not likely to be described as a *στερεὸν σῶμα*. Perhaps Aristotle's analogy with the human skeleton simply means that a figure made of a plastic substance must have a firm basis, just as a body has its skeleton for stability. Once the passage is seen in this way, both the model for a terracotta and the armature for a bronze are possible *στερεὰ σώματα*, since each functions as a firm basis, and as such is generally comparable to the skeletal basis of the animal body.

As we have seen, a similar interpretation also fits the two passages in which Aristotle actually mentions the word *κάναβος*. A human body is three-dimensional, whereas the drawings from which Aristotle draws his parallels are two-dimensional: a framework can be planar or solid without losing the quality of being a framework.

A derivative of *κάναβος* used by Aristophanes in association with ancient bronze working can be explained once *κάναβος* is interpreted as an armature. In Aristophanes fr.699 *καναβευμάτων* is used metaphorically as a source of jokes or clever remarks.

*ρήματά τε κομψὰ καὶ παίγνι' ἐπιδεικνύναι
πάντ' ἀπ' ἀκροφυσίων κἀπὸ καναβευμάτων*²⁴

“To show off clever words and tricks, direct from the bellows mouth and armature.” *καναβευμάτων* has been translated as ‘foundry mould’,²⁵ used here in conjunction with *ἀκροφυσίων* ‘bellows nozzle’. Beyond their connection with the foundry, the bellows and the mould (the latter commonly called *λίγδος*) are vaguely related in that bellows fan the fire that heats the mould. Edmonds, however, in suggesting that *καναβευμάτων* means ‘mould’, attributes to a word probably derived from *κάναβος* a meaning that is not related to the common significance of *κάναβος* as a skeletal framework or armature. The passage may be interpreted as meaning witticisms which are as unspoiled as the air blowing from the bellows nozzle²⁶ and as un-

examples from Keos (see n.7 *supra*). Nancy Bookidis has pointed out to me a rare example of a cored terracotta sculpture from Corinth: a male left shoulder was built around a bundle of straw; it fired badly, which may be why the procedure was not repeated.

²⁴ CAF I p.562 fr.699. *ἀποκναβευμάτων* *codd.*; *καναβευμάτων* Kock. See LSJ, *κινάβευμα*.

²⁵ Edmonds I 767.

²⁶ So Edmonds I 767.

trammelled as the armature upon which a statue has yet to be formed. On the other hand, *κομψία* can have the slightly derogatory connotation of subtle words. Hesychius defines *κιναβεύματα* as *πανουργεύματα* 'knaveish' or 'evil tricks', while Photius defines *κιναβευμάτων* as *πονηρευμάτων* 'villainies'. The passage may thus be derogatory, referring to words and tricks that are overly subtle and that resemble the air blown from the bellows and need the support of an armature.²⁷ Either of these interpretations of the fragment would accord with the meaning of *κάναβος* as framework or armature as found in other ancient authors.²⁸

In all of the passages examined *κάναβος* can be interpreted as 'framework'. This framework can be two-dimensional, as *ὑπογραφή*, or it can be three-dimensional, as a skeleton or as an armature for a bronze. In either case the basic concept is the same. So understood, this meaning of *κάναβος* clarifies Pollux's account of bronze casting, our only ancient full description of the direct lost-wax technique.²⁹

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²⁷ I am indebted to Professor Ronald S. Stroud for this idea.

²⁸ Although much more needs to be known about ancient iron- and bronze-working, it is clear that the tools and procedures necessary for working iron are distinct from those used in a bronze foundry (see Blümner, *op.cit.* [*supra* n.4] IV 278–90, 340–74). Thus it is not difficult to imagine a craftsman who specialized in preparing iron *κάναβοι* for the founders of such bronzes as the Peiraeus Kouros and the Delphi Charioteer. Such a profession may be intended by the word *καναβιο(υ)ργός* (LSJ 'maker of *κάναβοι*') applied to a man named Kittos, upon whom bad luck is wished in a fourth-century B.C. Attic *defixio* (IG III³ 87). L. Robert, however, has interpreted *καναβιουργός* as 'hemp-worker' (*Noms indigènes dans l'Asie-Mineure gréco-romaine* I [Paris 1963] 146); cf. T. Drew-Bear, *Glotta* 50 (1972) 78–79.

²⁹ I am grateful to Professors Henry R. Immerwahr, James R. McCredie, David Sider and Mr Richard S. Mason, for their helpful suggestions concerning the content and organization of this paper.