

# A Systematic Nomenclature for the *Drosophila* Ventral Nervous System

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## Abstract

Insect nervous systems are proven and powerful model systems for neuroscience research with wide relevance in biology and medicine. However, descriptions of insect brains have suffered from a lack of a complete and uniform nomenclature. Recognising this problem the Insect Brain Name Working Group produced the first agreed hierarchical nomenclature system for the adult insect brain, using *Drosophila melanogaster* as the reference framework, with other insect taxa considered to ensure greater consistency and expandability (Ito et al., 2014). Ito et al. (2014) purposely focused on the gnathal regions that account for approximately 50% of the adult CNS. We extend this nomenclature system to the sub-gnathal regions of the adult *Drosophila* nervous system to provide a nomenclature of the so-called ventral nervous system (VNS), which includes the thoracic and abdominal neuromeres that was not included in the original work and contains the neurons that play critical roles underpinning most fly behaviours.

## Background

Insect nervous systems are proven and powerful model systems for neuroscience research with wide relevance for biology and medicine. Although vast anatomical, physiological and molecular data are already available, integrating this information into a common analytical framework would generate an even more powerful resource. Computational analysis combined with digital microscopy now make it possible to consolidate data from multiple techniques and transform how we analyse nervous system function (Jenett et al., 2006; Dance, 2015; Boettiger et al., 2016). It is no longer sufficient to use 2D labelled diagrams and photomicrographs to identify and define anatomical structures, as it is now possible to use multilayer microscopy with computational reconstruction to precisely define and allocate boundaries and structures in 3D. This requires a systematic and consistent nomenclature to precisely define anatomical structures and boundaries. Furthermore the definitions and nomenclature need to be rationalised as multiple names can be used for the same structure. The precise inter relationships between structures also need to be specified. Once this is complete, new findings can be more easily added to this framework allowing

42 a complete picture of all knowledge to be more readily accessed and enabling consistent analysis of  
43 anatomical data from different studies. Recognising this problem, a consortium of neurobiologists  
44 studying arthropod brains, the insect brain name working group (*Ito et al., 2014*) (IBNWG), was  
45 established and produced the first agreed hierarchical nomenclature system for the insect brain,  
46 using *Drosophila melanogaster* as the reference framework, with other insect taxa considered to  
47 ensure greater consistency and expandability (*Ito et al., 2014*). *Ito et al. (2014)* purposely focused  
48 on the gnathal regions that account for approximately 50% of the total adult Central Nervous  
49 System. Here we extend this nomenclature system (*Ito et al., 2014*) to the sub-gnathal regions of  
50 the adult *Drosophila* nervous system to provide a nomenclature of the so-called ventral nervous  
51 system (VNS), which includes the thoracic and abdominal neuromeres that was not included in the  
52 original work (*Ito et al., 2014*) and contains the neurons that play a critical role in effecting most fly  
53 behaviors. The VNS is an often overlooked but vital part of the insect central nervous system that is  
54 necessary for nearly all motor output (*Burrows, 1996; Büschges et al., 2008; Robertson et al., 1982*),  
55 and will be increasingly important as interest in behavior grows (*Lemon et al., 2015; Pitmon et al.,*  
56 *2016; Seeds et al., 2014*). *Power (1948), Merritt and Murphey (1992)* and *Boerner and Duch (2010)*  
57 all made previous attempts to provide anatomical frameworks for the fly VNS. These core works,  
58 plus many other additional studies, have created a rich catalogue of anatomical detail but the  
59 inconsistent approach to nomenclature and definitions has created ambiguity and confusion. The  
60 aim of the *Drosophila* adult VNS working group (DAVWG) was to create a nomenclature, definitions  
61 and spatial boundaries for the key anatomical entities of the *Drosophila* VNS.

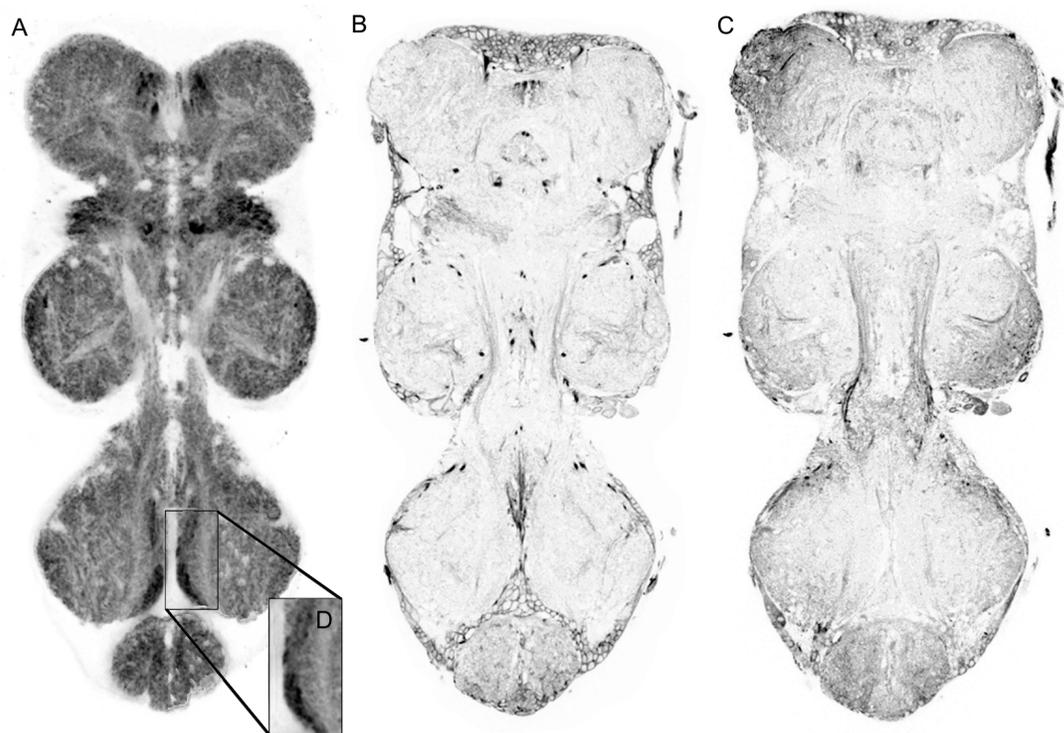
## 62 **Organization of the Working Group**

63 The initial phase of work was similar to that adopted by the original Insect Brain Name Working  
64 Group (IBNWG) to create the nomenclature for the *Drosophila* brain (*Costa et al., 2013; Ito et al.,*  
65 *2014*). We gathered together researchers who are leading relevant work or those who have made  
66 recognized historical contributions to the field of *Drosophila* VNS. We also included some individuals  
67 who have an expertise in development, some with knowledge of the VNS in other insect species,  
68 as well as representatives of the original IBNWG 2014. Prior to the workshop, a small group  
69 compiled a document listing all of the named regions found in the published literature and from  
70 the existing *Drosophila* anatomy ontology (*Costa et al., 2013*). The group also created additional  
71 representative anatomical datasets where required. These datasets and a list of definitions were  
72 assembled into a working document and shared online prior to the workshop. At the workshop  
73 held at Janelia Research Campus on October 2013 the task group systematically reviewed the  
74 published anatomical data and unpublished data provided by the participants, while compiling a  
75 proposed list of of nomenclature that was agreed upon by all members. Afterwards, the working  
76 document and its content were updated and reviewed by the task group. The document was next  
77 distributed to a wider constituency of individuals with a broader species based knowledge as well as  
78 any interested parties for feedback. Feedback and amendments were agreed, ultimately resulting  
79 in this publication.

## 80 **Establishing the anatomical framework**

81 Establishment of a systematic nomenclature requires two steps: (1) a clear morphological and  
82 spatial definition of all the structures to be named and (2) a standard and clear naming scheme. The  
83 neuropilar regions of the VNS are typically regarded as being 'unstructured' or 'tangled', or having  
84 a fine, granular appearance in sections (*Merritt and Murphey, 1992*) with different regions distin-  
85 guished only by general spatial terms such as, 'intermediate' (*Merritt and Murphey, 1992*) or 'dorsal'.  
86 Despite this, different volumes of VNS neuropil can be defined in relation to fixed landmarks such as  
87 the longitudinal tracts, commissures (*Shepherd et al., 2016*). Recently, *Shepherd et al. (2016)* have  
88 used the primary projections of neuronal hemilineages to provide a vital organizational principle for  
89 defining the substructure of the neuropil. Although these landmarks may not always correspond to

90 the underlying functional organisation, they provide a consistent means of structurally defining  
91 neuropil regions.



**Figure 1.** Frontal section through midsection of the adult VNS. **A** shows the neuropil marked by N-cadherin expression in the synapses, **B** shows neuroglial expression demonstrating the high intensity points of the tracts that guide lineage neurite projection, **C** shows tubulin expression used to highlight tracts and **D** highlights the dense neuropil regions associated with sensory connections. All levels are inverted for the purposes of clarity in print.

92 To provide an initial framework for establishing distinct boundaries within the VNS, we created  
93 confocal datasets that reveal various aspects of VNS structure, including tracts and neuropil. An  
94 anti alpha tubulin antibody (**Figure 1C**) was used to reveal fibrous structures such as longitudinal  
95 tracts and commissures. An anti-Drosophila N-cadherin (DNx8) was used to visualize neuropils  
96 according to the density of an active-zone-specific protein, mirroring exactly the structures revealed  
97 by nc82 (bruchpilot) immunostaining (*Wagh et al., 2006*). This allowed us to distinguish between  
98 neuropils that are poor in synapses, such as regions occupied by axons, primary neurites, and  
99 glial processes, which are left unlabeled (**Figure 1A**), and synapse-rich regions such as the primary  
100 sensory neuropils (**Figure 1D**). The anti-neuroglial antibody (**Figure 1B**) was used to reveal the  
101 projections of clonally related neurons in neuroblast (NB) hemilineages (*Shepherd et al., 2016*).  
102 The images obtained with these labeling methods are available via the Brain Explorer function of  
103 the FlyBrain Neuron Database (<http://ndb.flybrain.org>). To ensure consistency with previous and  
104 ongoing studies, we took into account the known projection patterns of various neurons, including  
105 those of single identified neurons (giant fiber neuron) and the trajectories of their fiber bundles  
106 (sensory afferents from the halteres). Information about VNS organization in other insect species  
107 was integrated wherever relevant.

### 108 **The naming scheme**

109 The key principle for the rationalisation of the nomenclature was to, wherever possible, integrate  
110 the current terminology into the newly developed standard. In doing so, we reused the existing  
111 terminology as much as possible and changes were only made where there was a need to remove

112 ambiguity. When multiple names for an anatomical entity had been used in the literature, the  
113 principle was to give preference to the name that was in most popular usage. Where there was a  
114 need to create new terms we developed a standard and clear naming scheme (e.g. naming of the  
115 newly identified structures). We also sought consistency with terms used for earlier developmental  
116 stages and in other insects but in all cases avoiding the implication of any homology. We were also  
117 driven by the need to separate the naming scheme, driven by morphology, from function. Details  
118 about the latter, however, have been included in the definition, whenever known.

119 In developing a standard and clear naming scheme, we wished to encourage a more consistent  
120 use of terms. We recognize, however, that users may be inclined to continue using the nomenclature  
121 of their choice. In acknowledging this issue, we have captured all known synonyms for each term,  
122 including references. Users will be able to search for terms in the DAO using any of these synonyms.

## 123 **Abbreviations**

124 We adopted a systematic approach when developing abbreviations for each named anatomical  
125 entity based on the following points. The first was to adopt abbreviations that are unique across  
126 the whole CNS, avoiding abbreviations already in use for unrelated regions in the VNS and the brain  
127 (for disambiguation purposes, the letter case is ignored). The second was to create a system in  
128 which related entities would be easily recognizable (for example, all commissures). Finally, we tried  
129 to be consistent with standard neuroanatomical nomenclature e.g. BrainName (*Ito et al., 2014*).  
130 The reasoning behind each abbreviation change was recorded and embedded in the definition.

131 When referring to the neuromere and related structures, abbreviations were changed from a single  
132 letter or number to 'Pro', 'Meso' and 'Meta'. This removed confusion with positional abbreviations  
133 such as posterior or medial.

134 The use of the single letter 'N', which is used widely (neuromere, neuropil, nerve, neuron) was  
135 reserved, at this level for "nerve" and the other larger gross anatomy structures differentiated with  
136 additional letters (e.g. 'Nm' for neuromere and 'Np' for neuropil). The letter 'C' was used to identify  
137 commissures.

138 In cases where multiple abbreviations had developed for specific structures the abbreviation  
139 that provided the clearest indication with least likelihood of confusion was agreed by consensus.

140 Known abbreviations were captured as synonyms and references were added whenever possible.  
141

## 142 **Axis orientation**

143 Unlike the cephalic neuromeres (*Ito et al., 2014*) the issue of specifying general axis orientation  
144 for the VNS is relatively straightforward. The neuroaxis and the body axis are the same, with the  
145 prothoracic neuromere being anteriormost and the abdomen (abdominal ganglionic complex)  
146 being the most posterior. In the dorsal/ventral plane the tectulum is superior or dorsal and the leg  
147 nerves inferior or ventral. The left and right sides are applied as if the sample is viewed from the  
148 above (superior/dorsal). The axis is shown in all figures by arrows pointing towards the anterior (A),  
149 superior/dorsal (S) and the right (R).

## 150 **Identifying and defining structures**

### 151 **Neuromere Boundaries**

152 The thoracic neuromeres consist of three paired enlargements at the anterior end of the VNS,  
153 corresponding to the prothoracic, mesothoracic and metathoracic segments, and a single posterior,  
154 dorsally located mass, the abdominal neuromeres, that is composed of all the fused abdominal  
155 neuromeres.

156 The scaffold of axon fibres revealed by neuroglial expression provides a tool to define the  
157 internal segmented structure of the neuropils of the VNS. Since each neuromere is founded by a  
158 specific set of NBs, the neuroglial bundles produced by their progeny create a neuromere specific

**Table 1.** Summary of the nomenclature for VNS structures.

<b>Major neuromeres and Neuropil</b> Prothoracic neuromere (ProNm) Mesothoracic neuromere (MesoNm) Accessory mesothoracic neuropil (AMNp) Tectulum (Tct) Metathoracic neuromere (MetaNm) Abdominal neuromeres (ANm)	<b>Described Tracts</b> Dorsal lateral tract (DLT) Intermediate tract of dorsal cervical fasciculus (ITD) Dorsal Medial Tract (DMT) Dorsal lateral tract of ventral cervical fasciculus (DLV) Ventral lateral tract (VLT) Ventral median tract of ventral cervical fasciculus (VTV)
<b>The Commissures</b> Prothoracic Anterior Ventral Anterior Commissure (ProAVAC) Prothoracic Anterior Ventral Posterior Commissure (ProAVPC) Mesothoracic Anterior Ventral Anterior Commissure (MesoAVAC) Mesothoracic Anterior Ventral Posterior Commissure (MesoAVPC) Metathoracic Anterior Ventral Anterior Commissure (MetaAVAC) Metathoracic Anterior Ventral Posterior Commissure (MetaAVPC) Prothoracic Anterior Intermediate Commissure (ProAIC) Mesothoracic Anterior Intermediate Ventral Commissure (MesoAIVC) Mesothoracic Anterior Intermediate Dorsal Commissure (MesoAIDC) Metathoracic Anterior Intermediate Ventral Commissure (MetaAIVC) Metathoracic Anterior Intermediate Dorsal Commissure (MetaAIDC) Prothoracic Posterior Intermediate Anterior Commissure (ProPIAC) Prothoracic Posterior Intermediate Posterior Commissure (ProPIPC) Prothoracic Posterior Intermediate Anterior Dorsal (ProPIDC) Prothoracic Posterior Intermediate Anterior Ventral (ProPIVC) Mesothoracic Posterior Intermediate Anterior Commissure (MesoPIAC) Mesothoracic Posterior Intermediate Posterior Commissure (MesoPIPC) Metathoracic Posterior Intermediate Anterior Commissure (MetaPIAC) Metathoracic Posterior Intermediate Posterior Commissure (MetaPIPC) Prothoracic Posterior Dorsal Commissure (ProPDC) Mesothoracic Posterior Dorsal Commissure (MesoPDC) Metathoracic Posterior Dorsal Commissure (MetaPDC) Commissure of the fine fibers of the intermediate tract of the dorsal cervical fasciculus (CFF)	Median dorsal abdominal tract (MDT) Ventral cervical fasciculus (VCF) Dorsal cervical fasciculus (DCF) Ventral ellipse (VE)
Commissure of prothoracic neuromeres (CPN) Dorsal accessory commissure of the mesothoracic neuromeres (DAM)	<b>The peripheral nerves</b> Cervical connective (CvC) Cervical nerve (CvN) Dorsal prothoracic nerve (DProN) Prosternal nerve (PrN) Prothoracic chordotonal nerve (ProCN) Prothoracic accessory nerve (ProAN) Ventral prothoracic nerve (VProN) Prothoracic leg nerve (ProLN) Anterior dorsal mesothoracic nerve (ADMN) Posterior dorsal mesothoracic nerve (PDMN) Mesothoracic accessory nerve (MesoAN) Mesothoracic leg nerve (MesoLN) Dorsal metathoracic nerve (DMetaN) Metathoracic leg nerve (MetaLN) First abdominal nerve (AbN1) Second abdominal nerve (AbN2) Third abdominal nerve (AbN3) Fourth abdominal nerve (AbN4) Abdominal nerve trunk (AbNT)
	<b>Individual Neurons</b> Giant fiber neuron (GF)

159 set of anatomical markers that provide a framework to define each neuromere as well as the  
 160 tectulum and many of the commissures.

### 161 **Tracts and Commissures**

162 **Power (1948)** defined, later volumetrically clarified by **Boerner and Duch (2010)**, the major commis-  
 163 sures of the adult VNS. **Truman et al. (2004)** showed that in the larva the postembryonic secondary  
 164 lineages crossed the midline via specific and invariant commissural pathways. Using the neuroglial  
 165 labelled tracts **Shepherd et al. (2016)** were able to link the larval commissures to their adult coun-  
 166 terparts to reveal the developmental origins of many of the commissures in the adult (VNS). This  
 167 work not only confirmed the developmental origins of the commissures identified by **Power (1948)**  
 168 but also identified several smaller commissures not previously observed.

### 169 **The Tectulum**

170 In the transverse plane the neuroglial tracts also help to define another substructure within  
 171 the VNS: the tectulum. **Power (1948)** defined this region as a "distinct subdivision of the thoracic  
 172 regions of the [VNS]. The region forms a saddle-like structure located dorsally primarily over the  
 173 mesothoracic neuropil but extending over the posterior-most region of the prothoracic neuromere  
 174 and the anteriormost region of the metathoracic neuropil". Despite the subsequent work done on  
 175 the VNS this remained the best definition of the tectulum.

176 The neuroglial framework of lineage derived from primary neurite tracts provides a clear and  
 177 easily recognisable boundary that more precisely circumscribes the tectulum (**Shepherd et al.,**  
 178 **2016**). The tectulum is the dorsal region of the neuropil posterior to the anterior most limits of the  
 179 T1 hemilineage 12B neuroglial tract but dorsal to the tracts from the T1 hemilineages 12B, 6A and  
 180 B, 23 17 and 18. It extends posteriorly through T2 remaining dorsal to the tracts from hemilineages  
 181 3B, 6A and B and 23 to the entry point of hemilineage 3A in T3.

## 182 **The Peripheral Nerves**

183 Most of the peripheral nerves have been historically defined by **Power (1948)** in which case the  
184 definitions were simply collated. However for some of the abdominal nerves we decided to use  
185 later terms (**Shepherd and Smith, 1996**) which names each nerve according to its neuromere of  
186 origin, giving them a more consistent naming scheme than the original.

## 187 **Discussion**

188 In this project, we addressed two primary issues in order to create a clearer understanding of the  
189 VNS structure and to promote dialogue among neuroscience researchers. The first was to establish  
190 a common anatomical framework to precisely define and describe, textually and spatially, the  
191 anatomical organization of the VNS. The second was to create a clear and consistent naming scheme  
192 for each anatomical entity. The detailed VNS map we provide will be invaluable for integrating  
193 past and future work into a common space, thereby contributing to new lines of investigation. In  
194 addition, our effort will also inform researchers working with other insects, providing them with a  
195 template that could be adapted to their own model organism.

196 Although the nomenclature developed in this project will serve as the standard, we acknowledge  
197 that to be useful it must be maintained as a 'living' process and evolve as our understanding of  
198 the VNS structure and function grows. Future revisions and additions will be required and this  
199 will be handled via the existing online system for posting anatomy ontology suggestions located  
200 at [github.com/FlyBase/drosophila-anatomy-developmental-ontology/issues](https://github.com/FlyBase/drosophila-anatomy-developmental-ontology/issues) and maintained by  
201 [VirtualFlyBrain.org](https://VirtualFlyBrain.org).

202 Unlike the brain, the VNS in insects demonstrates extraordinary diversity in its gross organisation  
203 and structure (**Niven et al., 2008**). There is, however, a large anatomical literature for several insect  
204 groups that exhibit markedly different VNS structures (e.g. grasshoppers, crickets and moths)  
205 that sometimes use the same terms as used for *Drosophila*. Whilst it is desirable to describe the  
206 correspondence of terminology between species, as was done for the more conserved insect brain,  
207 for the VNS this is not so readily achievable and only possible for major structures (neuromere,  
208 tract, nerve). To create consistent cross species terminology for more detailed structures requires a  
209 programme of work to confirm homology rather than rely on inference from similar structure. For  
210 this reason we elected to not expand this nomenclature to other insects. It is intended that our  
211 work will provide a framework to then explore cross species homologies in the VNS.

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## 296 Appendix 1

### 297 Overview of nomenclature

298 Here we provide the agreed anatomy terms, each with a short description. We also highlight  
299 any changes we have made from what was considered the classical definition with the  
300 group's reasoning for making the change.

### 301 Ventral Nervous System (VNS)

302 The non-cephalic division of the central nervous system consolidated into a single ganglion located  
303 in the ventral thorax. The ganglion contains all of the thoracic and abdominal neuromeres (**Figure 1**).  
304 For this reason it was called the thoracicoabdominal ganglion by **Power (1948)** but is often referred  
305 to as the ventral nerve cord (VNC) although the VNC would include the suboesophageal ganglion  
306 (**Niven et al., 2008**). The VNS ganglion has three paired enlargements at its anterior end, thoracic  
307 neuromeres, which correspond to the prothoracic, mesothoracic and metathoracic segments, with  
308 a single posterior, dorsally located mass, the abdominal neuromeres that contains all the fused  
309 abdominal neuromeres.

#### 310 Changes:

311 Although the name thoracico-abdominal ganglion (TAG) (**Power, 1948**) was initially agreed by  
312 the group, many who worked in both larvae and adult felt that ventral nerve cord (VNC) was  
313 more appropriate and indeed was often used in the adult. However, this structure includes the  
314 suboesophageal ganglion. Ultimately, ventral nervous system (VNS) was agreed upon with all  
315 alternatives recorded as synonyms.

#### 316 Synonyms:

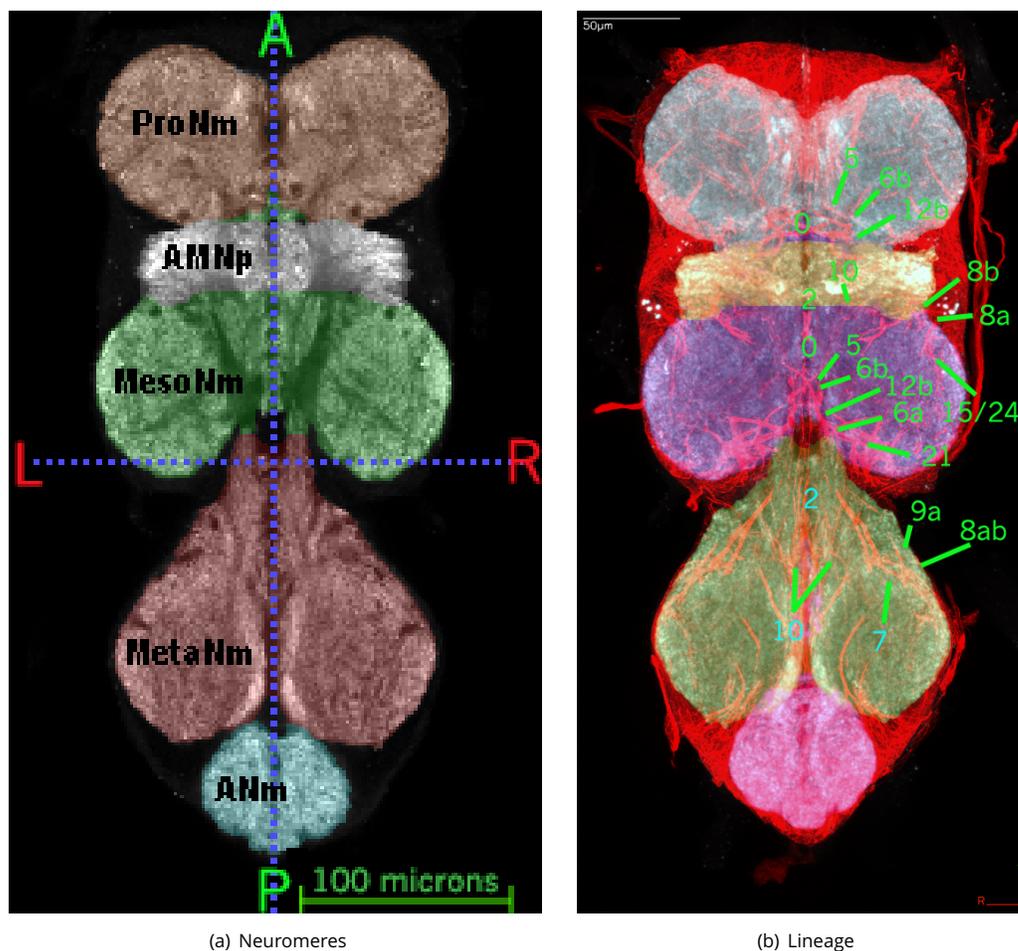
- 317 • VNS (Proposed by group),
- 318 • thoracico-abdominal ganglion (**Power, 1948**),
- 319 • thoracico-abdominal ganglia (**Lundquist and Nässel, 1990**),
- 320 • adult ventral nerve cord (**Niven et al., 2008**),
- 321 • VNC [BROAD] (**Niven et al., 2008**),
- 322 • TAC (**Merritt and Murphey, 1992**),
- 323 • TAG (**Ito et al., 2014**),
- 324 • ThGng (**Miller and Demerec, 1950**),
- 325 • thoracic + abdominal ganglion,
- 326 • T1 + T2 + T3 + A1 + A2 + A3 + A4 + A5 + A7 + A8,
- 327 • thoracico-abdominal center (**Power, 1948; Merritt and Murphey, 1992**),
- 328 • thoracic nerve center (**Miller and Demerec, 1950**),
- 329 • abdominal ganglion RELATED (**Power, 1948**).

### 330 Dense Neuropil

331 Dense neuropil, as referred to later in this document, indicates more tightly packed synaptic regions.  
332 It can be identified by a notably brighter signal than that from the general surrounding neuropil  
333 when imaged using standard immunofluorescence confocal microscopy targeting either NC82 or  
334 N-cadherin. See **Figure 1(D)** for an example.

### 335 Thoracic Neuromeres

336 The three thoracic neuromeres are segmentally homologous and share common structural features.  
337 The detailed organisation of serially homologous tracts and neuropil regions within the leg neuropils,  
338 as well as the angle of entry of the relevant leg nerve into the VNS, indicate that the thoracic  
339 neuromeres have undergone rotation during development. This is such that the prothoracic  
340 neuromeres are rotated anteriorly, the mesothoracic and metathoracic and neuromeres rotated  
341 posteriorly.



**Appendix 1 Figure 1.** Frontal section through midsection of adult VNS template with painted neuromeres also showing lineage tract boundaries. Shown in **Figure 1(a)** is the labelled neuromeres: Prothoracic Neuromere - ProNm (described in Prothoracic Neuromere (ProNm)), Accessory Mesothoracic Neuropil - AMNp (described in Accessory Mesothoracic Neuropil (AMNp)), Mesothoracic Neuromere - MesoNm (described in Mesothoracic Neuromere (MesoNm)), Metathoracic Neuromere - MetaNm (described in Metathoracic Neuromere (MetaNm)) and Abdominal Neuromeres - ANm (described in Abdominal Neuromeres (ANm)). To show the lineage basis for internal boundaries **Figure 1(b)** shows a thick (22  $\mu\text{m}$ ) midsection slice of neuroglial (red) with the labelled neuropil (painted greyscale), showing the painted neuromeres with labelled examples of the lineage tracts defining the internal boundaries (see definitions in Prothoracic Neuromere (ProNm) - Accessory Mesothoracic Neuropil (AMNp) & Metathoracic Neuromere (MetaNm) - Abdominal Neuromeres (ANm)).

342 Prothoracic Neuromere (ProNm)

343 **Defined region shown in Appendix 1 Figure 2**

344 The anteriormost of the 4 major neuropils that makes up the VNS and derives almost com-  
345 pletely from the somata and projections of central neurons derived from the prothoracic array  
346 of neuroblasts, as well as the axonal projections of sensory afferents from the prothoracic legs  
347 and and prothorax. The posterior margin is defined by the neuroglial tracts from the posterior T1  
348 hemilineages 0, 2, 3, 6, 11 and 19, all of which project anteriorly into the neuromere (**Figure 1(b)**).  
349 The paired neuropil is formed as two more or less spherical masses.

350 **Changes:**

351 The abbreviation was changed to resolve the clash for the original abbreviation PN with those for  
352 both the prosternal nerve and the adult antennal lobe projection neuron. The internal boundaries  
353 were clarified in relation to lineage tracts (*Shepherd et al., 2016*).

354 **Synonyms:**

- 355 • ProNm (Proposed by group),
- 356 • Pro (*Merritt and Murphey, 1992*),
- 357 • PN (*Power, 1948*).

358 Mesothoracic Neuromere (MesoNm)

359 **Defined region shown in Appendix 1 Figure 3**

360 The 2nd (anterior-posterior) of the 4 major neuropils of the VNS that derives almost completely  
361 from the somata and projections of central neurons derived from the mesothoracic array of  
362 neuroblasts as well as the axonal projections of sensory afferents from the mesothoracic legs and  
363 and mesothorax. The mesothoracic neuromere is closely associated with two distinct subdivisions of  
364 the thoracic neuropils: the accessory mesothoracic neuromere and the tectulum. The mesothoracic  
365 neuromere is contained anteriorly by the neuroglial tracts hemilineages from the anterior T2  
366 hemilineages 2, 7, 8, 9, 10, 15 and 16, all of which project posteriorly into the neuromere and define  
367 the anterior margin of the neuropil (**Figure 1(b)**). Similarly the posterior margin of the neuromere is  
368 defined by the neuroglial tracts from the posterior hemilineages 0, 3, 6, 11, 19, and 21, all of which  
369 project anteriorly into the neuromere (**Figure 1(b)**).

370 **Changes:**

371 The abbreviation was changed for consistency. The internal boundaries were clarified in relation  
372 to lineage tracts (*Shepherd et al., 2016*).

373 **Synonyms:**

- 374 • MesoNm (Proposed by group),
- 375 • Meso (*Merritt and Murphey, 1992*),
- 376 • MN (*Power, 1948*).

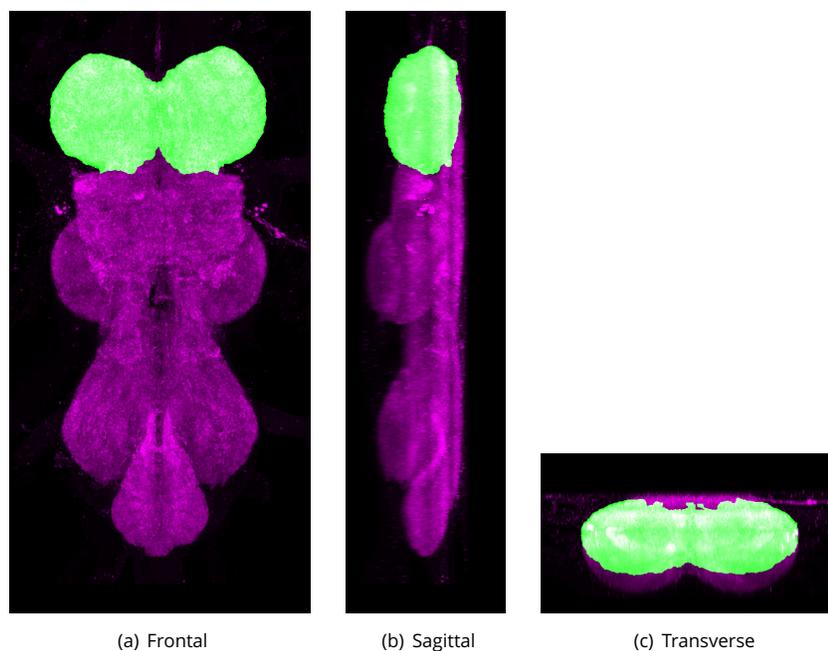
377 Accessory Mesothoracic Neuropil (AMNp)

378 **Defined region shown in Appendix 1 Figure 4**

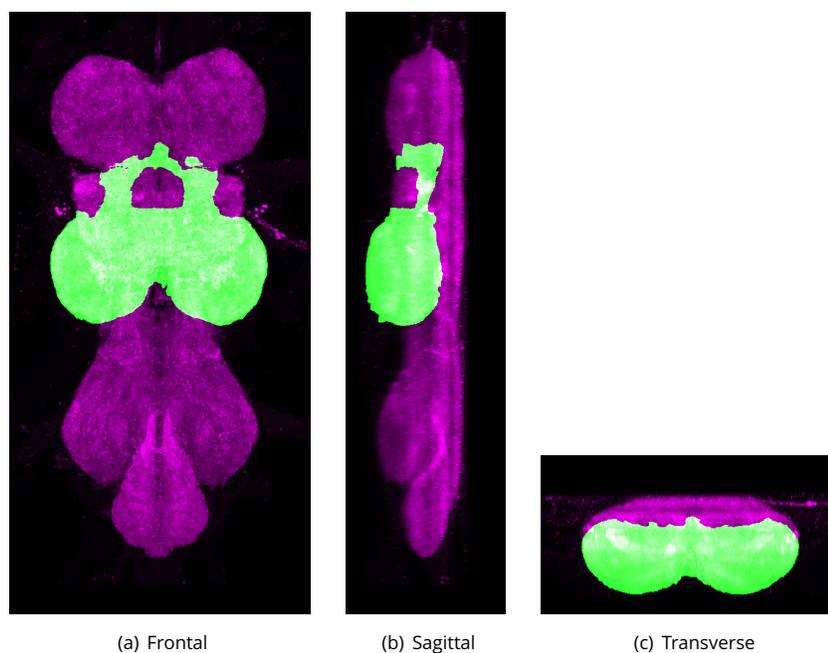
379 The accessory mesothoracic neuropil (AMNp) is a distinct subdivision of the mesothoracic  
380 neuromere. It is formed of dense neuropil (as seen by brighter signal in NC82 or N-cadherin  
381 staining) largely from the sensory afferents entering the VNS via the Anterior Dorsal Median  
382 Nerve (ADMN) (*Power, 1948*). The AMNp sits at the interface between the pro- and mesothoracic  
383 neuromeres from which it is morphologically distinct with the tectulum (Tct) forming the dorsal  
384 boundary. The AMNp is bounded anteriorly by the posterior T1 hemilineages 0, 5, 6, 11, 19 and 23  
385 and posteriorly by the anterior T2 hemilineages 1, 2, 7, 8, 9, 15, and 16 (**Figure 1(b)**).

386 **Changes:**

387 After careful consideration it was concluded and agreed by all that the accessory region was  
388 indicated by the dense neuropil (see description) and that any area posterior to the prothoracic  
389 neuromere lineage boundary but not dense neuropil should be considered part of the mesothoracic



**Appendix 1 Figure 2.** The proposed volume definition for the Prothoracic Neuromere (ProNm). Maximum projections from the labelled orthogonal plane with ProNm shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 3.** The proposed volume definition for the Mesothoracic Neuromere (MesoNm). Maximum projections from the labelled orthogonal plane with MesoNm shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.

390 neuomere. This also meant that the accessory region should more correctly be labelled neuropil  
391 rather than a neuomere. The internal boundaries were clarified in relation to lineage tracts  
392 (*Shepherd et al., 2016*).

393 **Synonyms:**

- 394 • AMNp (Proposed by group),
- 395 • accessory mesothoracic neuomere (*Power, 1948*),
- 396 • Acc Meso (*Merritt and Murphey, 1992*),
- 397 • AMN (*Power, 1948*),
- 398 • ovoid (*Merritt and Murphey, 1992*).

399 Tectulum (Tct)

400 **Defined region shown in Appendix 1 Figure 5**

401 The tectulum is a distinct subdivision of the thoracic regions of the VNS. The region forms a  
402 saddle-like structure located dorsally, primarily over the accessory mesothoracic neuropil (AMNp)  
403 and the mesothoracic neuomere (MesoNm), but extending over the posterior-most region of  
404 the prothoracic neuomere (ProNm) and the anteriormost region of the metathoracic neuomere  
405 (MetaNm). Its internal boundaries within the VNS can be defined as the dorsal region of the neuropil  
406 posterior to the anteriormost limits of the hemilineage 12B neuroglial bundle in ProNm, but dorsal  
407 to the bundles from 12B, 6B, 23 17, 18B. Extending posteriorly through MesoNm to the entry point  
408 of hemilineage 3 in MetaNm.

409 **Changes:**

410 Abbreviation changed from Power's 'T' (*Power, 1948*) to avoid potential confusion. The internal  
411 boundaries were clarified in relation to lineage tracts (*Shepherd et al., 2016*).

412 **Synonyms:**

- 413 • Tct (Proposed by group),
- 414 • T (*Power, 1948*),
- 415 • flight neuropil RELATED (*Power, 1948; Leise, 1991*).

416 Flight Neuropil (FNp)

417 Neuropil that contains branches from neurons that drive wing elevators and depressors but also  
418 receives projections from flight proprioceptors wing hinge receptors and wing sensory hairs (*Leise,*  
419 *1991*).

420 **Synonyms:**

- 421 • FNp (Proposed by group).

422 Metathoracic Neuomere (MetaNm)

423 **Defined region shown in Appendix 1 Figure 6**

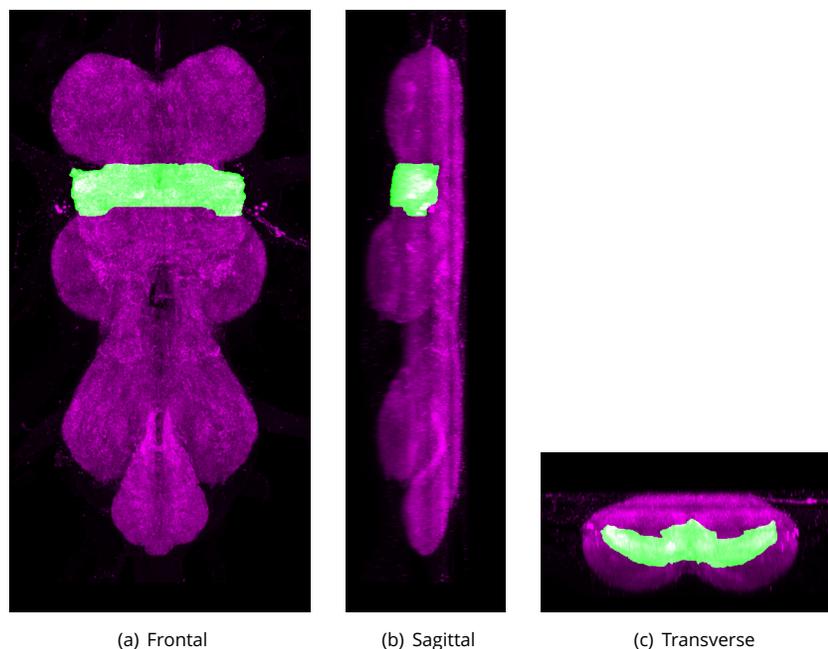
424 The 3rd (anterior-posterior) of the 4 major neuropils that make up the VNS (pro-, meso- and  
425 metathoracic neuomeres and ANm). It derives almost completely from the somata and projections  
426 of central neurons derived from the metathoracic array of neuroblasts as well as the axonal  
427 projections of sensory afferents from the metathoracic legs and and metathorax.

428 The metathoracic neuomere is contained anteriorly by the neuroglial tracts associated with the  
429 anterior T3 hemilineages 2, 7, 8, 9, 10, 15 and 16, all of which project posteriorly into the neuomere  
430 and define the anterior margin of the neuropil (*Figure 1(b)*). Similarly, the posterior margin of the  
431 neuomere is defined by the neuroglial tracts from the posterior hemilineages 0, 3, 6, 19, 20/22  
432 and 21, all of which project anteriorly into the neuomere.

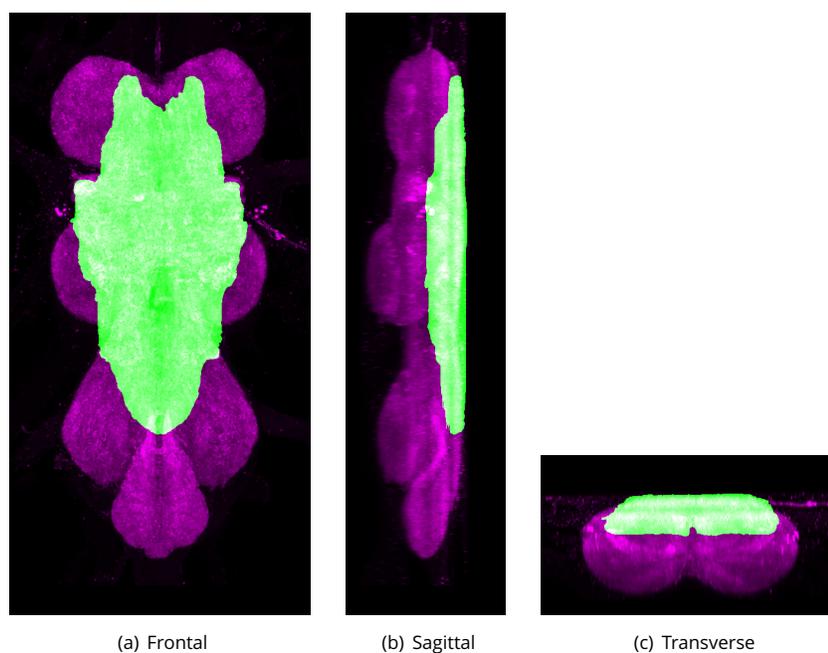
433 **Changes:**

434 The abbreviation was changed for consistency. The internal boundaries were clarified in relation  
435 to lineage tracts (*Shepherd et al., 2016*).

436 **Synonyms:**



**Appendix 1 Figure 4.** The proposed volume definition for the Accessory Mesothoracic Neuropil (AMNp). Maximum projections from the labelled orthogonal plane with AMNp shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 5.** The proposed volume definition for the Tectulum (Tct). Maximum projections from the labelled orthogonal plane with Tct shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.

- 437 • MetaNm (Proposed by group),
- 438 • Meta (*Merritt and Murphey, 1992*),
- 439 • MtN (*Power, 1948*).

#### 440 Abdominal Neuromeres (ANm)

##### 441 **Defined region shown in Appendix 1 Figure 7**

442 The 4th major neuropil situated at the posterior end of the VNS, composed of the fused  
443 neuromeres A1 through A8. The lineage composition of the abdominal neuromeres has not been  
444 undertaken but the anterior limit of the ANm is defined by reference to the neuroglial bundles  
445 delineating the posterior limit of the MetaNm. The neuropil regions posterior to the neuroglial  
446 tracts of hemilineages 0, 5, 6, 19 and 23 define the ANm.

##### 447 **Synonyms:**

- 448 • ANm (Proposed by group),
- 449 • AbGng (*Miller and Demerec, 1950*),
- 450 • AG (*Merritt and Murphey, 1992*),
- 451 • ac (*Power, 1948*),
- 452 • A1+A2+A3+A4+A5+A6+A7+A8,
- 453 • abdominal ganglia (*Merritt and Murphey, 1992*),
- 454 • abdominal ganglion (*Yu et al., 2010*),
- 455 • abdominal center (*Power, 1948*),
- 456 • abdominal nerve center (*Miller and Demerec, 1950*).

#### 457 **The Commissures**

458 The neuroglial tracts and lineage specific green florescent protein (GFP) expression reveal the  
459 developmental origins of many of the commissures in the adult VNS. In the larval VNS there are 5  
460 major commissures in each neuromere: the anterior (aD) and posterior (pD) dorsal commissures,  
461 the anterior (al) and posterior (pl) intermediate commissures, and the anterior ventral (aV) com-  
462 missure (*Truman et al., 2004*). The postembryonic hemilineages of the larval VNS cross the midline  
463 in specific and invariant commissures (*Truman et al., 2004*). Identification of the postembryonic  
464 hemilineages in the adult provides a definitive marker to link larval and adult VNS commissures  
465 (*Power, 1948; Merritt and Murphey, 1992*). From this, it is possible to develop a nomenclature for  
466 some of the adult commissures that recognises their larval origins (*Shepherd et al., 2016*).

#### 467 Prothoracic Anterior Ventral Anterior Commissure (ProAVAC)

468 ProAVAC is a ventral commissure formed by the axons of the ProNm hemilineage 1A as they cross  
469 the midline at the anteriormost margin of the prothoracic neuromere. The ProAVAC is ventrally  
470 located and lies at the ventralmost margins of the VNS, outside of the neuropil and cell cortex,  
471 crossing the midline anterior to the axon bundles from hemilineage 2A (*Shepherd et al., 2016*).

##### 472 **Synonyms:**

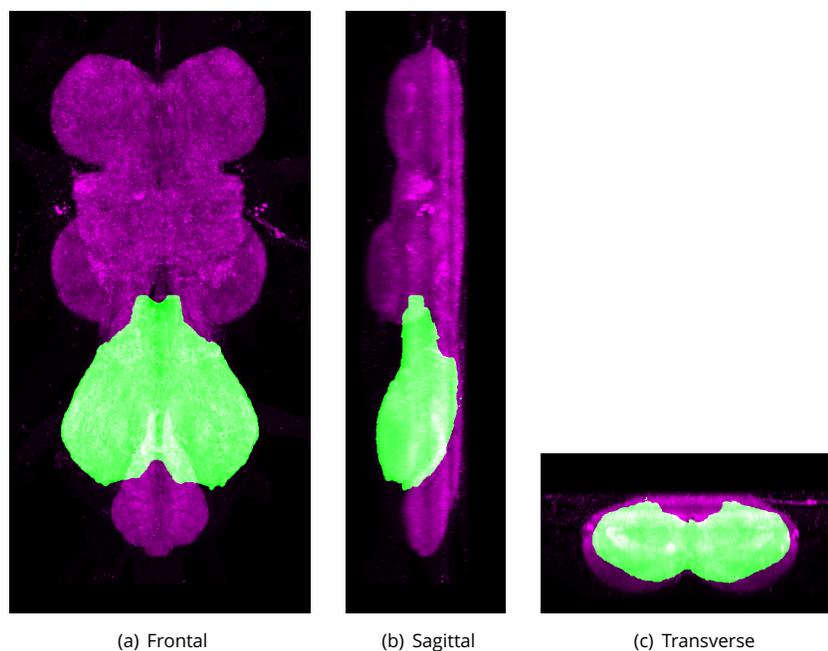
- 473 • ProAVAC (Proposed by group).

#### 474 Prothoracic Anterior Ventral Posterior Commissure (ProAVPC)

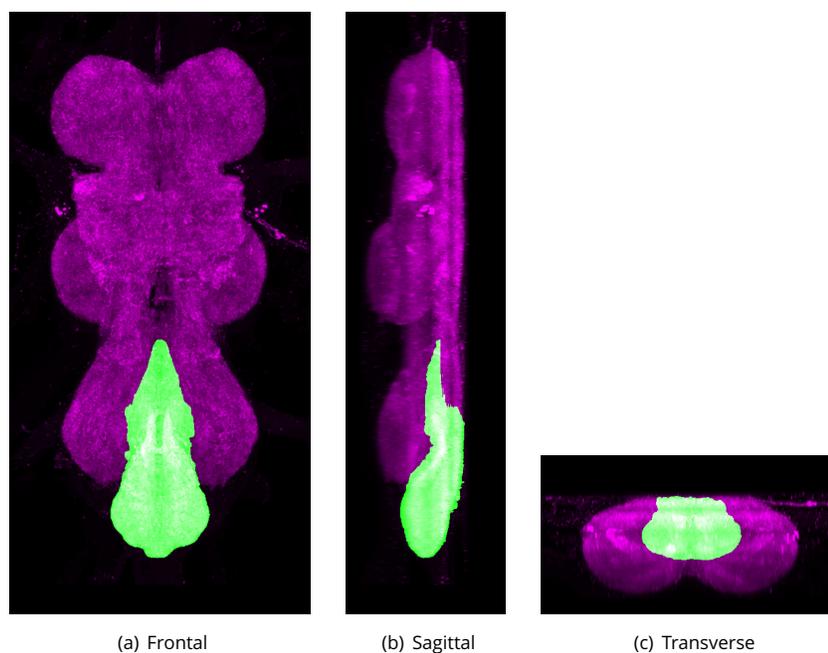
475 The ProAVPC is a ventral commissure formed by the axons of ProNm hemilineage 13B as they cross  
476 the midline at the anterior of the prothoracic neuromere. The ProAVPC is ventrally located and  
477 crosses the midline posterior to the axon bundles from hemilineage 2A (*Shepherd et al., 2016*).

##### 478 **Synonyms:**

- 479 • ProAVPC (Proposed by group).



**Appendix 1 Figure 6.** The proposed volume definition for the Metathoracic Neuromere (MetaNm). Maximum projections from the labelled orthogonal plane with MetaNm shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 7.** The proposed volume definition for the Abdominal Neuromeres (ANm). Maximum projections from the labelled orthogonal plane with ANm shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.

480 Mesothoracic Anterior Ventral Anterior Commissure (MesoAVAC)

481 The MesoAVAC is a ventral commissure formed by the axons of the MesoNm hemilineage 1A as  
482 they cross the midline at the anterior of the mesothoracic neuromere. The MesoAVAC s ventrally  
483 located and lies at the ventralmost margins of the VNS, outside of the neuropil and cell cortex,  
484 crossing the midline anterior to the axon bundles from hemilineage 2A (*Shepherd et al., 2016*).

485 This commissure was originally identified by *Power (1948)* as the Accessory Prothoracic Commis-  
486 sure.

487 **Synonyms:**

- 488 • MesoAVAC (Proposed by group),
- 489 • Accessory Prothoracic Commissure (*Power, 1948*),
- 490 • APC (*Power, 1948*).

491 Mesothoracic Anterior Ventral Posterior Commissure (MesoAVPC)

492 The MesoAVPC is a ventral commissure formed by the axons of the MesoNm hemilineage 13B as  
493 they cross the midline at the anterior mesothoracic neuromere. The commissure is ventrally located  
494 and crosses the midline posterior to the axon bundles from hemilineage 2A (*Shepherd et al., 2016*).

495 This commissure was originally identified by *Power (1948)* as the Ventral Accessory Commissure  
496 of the Mesothoracic Neuromere.

497 **Synonyms:**

- 498 • MesoAVPC (Proposed by group),
- 499 • Ventral Accessory Commissure of the Mesothoracic Neuromere (*Power, 1948*),
- 500 • VAC (*Power, 1948*).

501 Metathoracic Anterior Ventral Anterior Commissure (MetaAVAC)

502 The MetaAVAC is a ventral commissure formed by the axons of the MetaNm hemilineage 1A as they  
503 cross the midline at the anterior of the metathoracic neuromere. The MetaAVAC is ventrally located  
504 and lies at the ventralmost margins of the VNS, outside of the neuropil and cell cortex, crossing the  
505 midline anterior to the axon bundles from hemilineage 2A (*Shepherd et al., 2016*).

506 This commissure was originally identified by *Power (1948)* as the Accessory Commissure of the  
507 Metathoracic Neuromere.

508 **Synonyms:**

- 509 • MetaAVAC (Proposed by group),
- 510 • Accessory Commissure of the Metathoracic Neuromere (*Power, 1948*),
- 511 • ACM (*Power, 1948*).

512 Metathoracic Anterior Ventral Posterior Commissure (MetaAVPC)

513 The MetaAVPC is a ventral commissure formed by the axons of the MetaNm hemilineage 13B as  
514 they cross the midline at the anterior of the mesothoracic neuromere. The commissure is ventrally  
515 located and crosses the midline posterior to the axon bundles from hemilineage 2A (*Shepherd*  
516 *et al., 2016*).

517 **Synonyms:**

- 518 • MetaAVPC (Proposed by group).

519 Prothoracic Anterior Intermediate Commissure (ProAIC)

520 The ProAIC is a ventral commissure formed by the axons of the ProNm hemilineage 10B as they  
521 cross the midline in the anterior of the prothoracic neuromere. The commissure crosses the midline  
522 posterior to the axon bundles from hemilineage 2A (*Shepherd et al., 2016*). The ProAIC is posterior  
523 to the ProAVAC and unlike ProAVAC lies within the neuropil.

524 **Synonyms:**

- 525 • ProAIC (Proposed by group).

526 Mesothoracic Anterior Intermediate Ventral Commissure (MesoAIVC)

527 The MesoAIVC is a ventral commissure formed by the axons of the MesoNm hemilineage 10B as  
528 they cross the midline in the anterior of the mesothoracic neuromere. The commissure crosses the  
529 midline posterior to the axon bundles from hemilineage 2A (*Shepherd et al., 2016*). The MesoAIVC  
530 is posterior to the MesoAVAC and unlike MesoVAC lies within the neuropil.

531 **Synonyms:**

- 532 • MesoAIVC (Proposed by group).

533 Mesothoracic Anterior Intermediate Dorsal Commissure (MesoAIDC)

534 MesoAIDC is a dorsally located commissure formed by the axons of the mesothoracic hemilineage  
535 18B as they cross the midline in the anterior of the mesothoracic neuromere. The axons cross the  
536 midline anterior to the axons from hemilineage 2A (*Shepherd et al., 2016*).

537 **Synonyms:**

- 538 • MesoAIDC (Proposed by group).

539 Metathoracic Anterior Intermediate Dorsal Commissure (MetaAIDC)

540 The MetaAIDC is a dorsally located commissure formed by the axons of the metathoracic hemilin-  
541 eage 18B as they cross the midline in the anterior of the metathoracic neuromere. The axons cross  
542 the midline anterior to the axons from hemilineage 2A (*Shepherd et al., 2016*).

543 **Synonyms:**

- 544 • MetaAIDC (Proposed by group).

545 Prothoracic Posterior Intermediate Anterior Commissure (ProPIAC)

546 ProPIAC is a dorsally located commissure formed by the axons of the prothoracic hemilineage 8B  
547 as they cross the midline in the anterior of the prothoracic neuromere. The axons cross the midline  
548 posterior to the axons from hemilineage 2A (*Shepherd et al., 2016*).

549 **Synonyms:**

- 550 • ProPIAC (Proposed by group).

551 Prothoracic Posterior Intermediate Posterior Commissure (ProPIPC)

552 The ProPIPC is a posterior commissure formed by the axons of hemilineages 6B and 12B as they  
553 cross the midline in the prothoracic neuromere (*Shepherd et al., 2016*).

554 **Synonyms:**

- 555 • ProPIPC (Proposed by group).

556 Prothoracic Posterior Intermediate Anterior Dorsal Commissure (ProPIDC)

557 The ProPIDC is a dorsally located commissure formed by the axons of hemilineage 7B as they cross  
558 the midline in the anterior prothoracic neuromere (*Shepherd et al., 2016*).

559 **Synonyms:**

- 560 • ProPIDC (Proposed by group).

561 Prothoracic Posterior Intermediate Anterior Ventral Commissure (ProPIVC)

562 The ProPIVC is a commissure at a mid dorso-ventral plane formed by the axons from hemilineage  
563 5B as they cross the midline in the prothoracic neuromere (*Shepherd et al., 2016*).

564 **Synonyms:**

- 565 • ProPIVC (Proposed by group).

566 Mesothoracic Posterior Intermediate Anterior Commissure (MesoPIAC)

567 The MesoPIAC is an anterior commissure formed by the axons of hemilineages 7B and 8B as they  
568 cross the midline in the mesothoracic neuromere (*Shepherd et al., 2016*). This commissure was  
569 originally identified by *Power (1948)* as the Commissure of the Mesothoracic Neuromere.

570 **Synonyms:**

- 571 • MesoPIAC (Proposed by group),
- 572 • Commissure of the Mesothoracic Neuromere (*Power, 1948*),
- 573 • CMN (*Power, 1948*).

574 Mesothoracic Posterior Intermediate Posterior Commissure (MesoPIPC)

575 The MesoPIPC is a posterior commissure formed by the axons of hemilineages 5B, 6B and 12B as  
576 they cross the midline in the mesothoracic neuromere (*Shepherd et al., 2016*).

577 **Synonyms:**

- 578 • MesoPIPC (Proposed by group).

579 Metathoracic Posterior Intermediate Anterior Commissure (MetaPIAC)

580 The MetaPIAC is an anterior commissure in the metathorax formed by the axons from hemilineages  
581 7B and 8B as they cross the midline in the metathoracic neuromere. The commissure is posterior  
582 to the axons from hemilineage 2A (*Shepherd et al., 2016*).

583 This commissure was originally identified by *Power (1948)* as the Haltere Commissure.

584 **Synonyms:**

- 585 • MetaPIAC (Proposed by group),
- 586 • Haltere Commissure (*Power, 1948*),
- 587 • cHIN (*Merritt and Murphey, 1992; Tyrer and Gregory, 1982; Pflugger et al., 1988*),
- 588 • ITD-HC (*Boerner and Duch, 2010*),
- 589 • HC (*Power, 1948*).

590 Metathoracic Posterior Intermediate Posterior Commissure (MetaPIPC)

591 The MetaPIPC is a posterior commissure formed by the axons of hemilineages 5B, 6B and 12B as  
592 they cross the midline in the mesothoracic neuromere (*Shepherd et al., 2016*).

593 **Synonyms:**

- 594 • MetaPIPC (Proposed by group).

595 Prothoracic Posterior Dorsal Commissure (ProPDC)

596 The ProPDC is a posterior commissure formed by the axons from hemilineage 6A as they cross the  
597 midline in the dorsal prothoracic neuromere (*Shepherd et al., 2016*).

598 **Synonyms:**

- 599 • ProPDC (Proposed by group).

600 Mesothoracic Posterior Dorsal Commissure (MesoPDC)

601 The MesoPDC is a dorsal commissure formed by the axons of hemilineage 6A as they cross  
602 the midline in posterior mesothoracic neuromere (*Shepherd et al., 2016*). This commissure was  
603 originally identified by *Power (1948)* as the Posterior Dorsal Mesothoracic Decussation.

604 **Synonyms:**

- 605 • MesoPDC (Proposed by group),
- 606 • Posterior Dorsal Mesothoracic Decussation (*Power, 1948*),
- 607 • PDD (*Power, 1948*).

608 Metathoracic Posterior Dorsal Commissure (MetaPDC)

609 The MetaPDC is a dorsal commissure formed by the axons from hemilineage 6A as they cross the  
610 midline in the posterior metathoracic neuromere (*Shepherd et al., 2016*).

611 **Synonyms:**

- 612 • MetaPDC (Proposed by group).

613 Commissure of the Fine Fibers of the Intermediate Tract of the Dorsal Cervical Fasciculus  
614 (CFF)

615 A chiasma formed by the inner tracts of the intermediate tract of the dorsal cervical fasciculus  
616 (ITD-CFF), as they cross the midline above the mesothoracic neuromere and terminate on the  
617 opposite side. The chiasma of fine fibers is anterior to the haltere commissure (MetaPIAC).

618 **Synonyms:**

- 619 • CFF (*Power, 1948*).
- 620 • ITD-CFF BROAD (*Boerner and Duch, 2010*).

621 In addition to the commissures that can be related to the projections of specific hemilineages there  
622 are commissures that do not relate to specific clusters of central neurons.

623 Commissure of Prothoracic Neuromeres (CPN)

624 A transverse bundle of fibers that runs across the left and right prothoracic neuromeres. The fibers  
625 bow posteriorly and are located dorsal to the dorsal lateral tracts of the ventral cervical fasciculus  
626 (DLV). The arms of the bow are directed lateroanteriorly, and extend almost to the lateral borders  
627 of the neuromeres.

628 **Synonyms:**

- 629 • CPN (*Power, 1948*),
- 630 • prothoracic commissure *Bacon and Strausfeld (1986)*.

631 Dorsal Accessory Commissure of the Mesothoracic Neuromeres (DAM)

632 A transverse thin bundle of fibers that runs across the dorsoposterior region of the left and right  
633 mesothoracic neuromeres. It is located ventrally to the roots of the dorsal metathoracic (haltere)  
634 nerves, dorsal to the ventral ellipse, and ventroanterior to the haltere chiasma.

635 **synonyms:**

- 636 • DAM (*Power, 1948*).

### 637 **Described Tracts**

638 Several tracts are described by *Power (1948)* and later clarified by *Merritt and Murphey (1992)*.  
639 They were later put in a volumetric context by *Boerner and Duch (2010)*, who kindly made their data  
640 available for inclusion in this project.

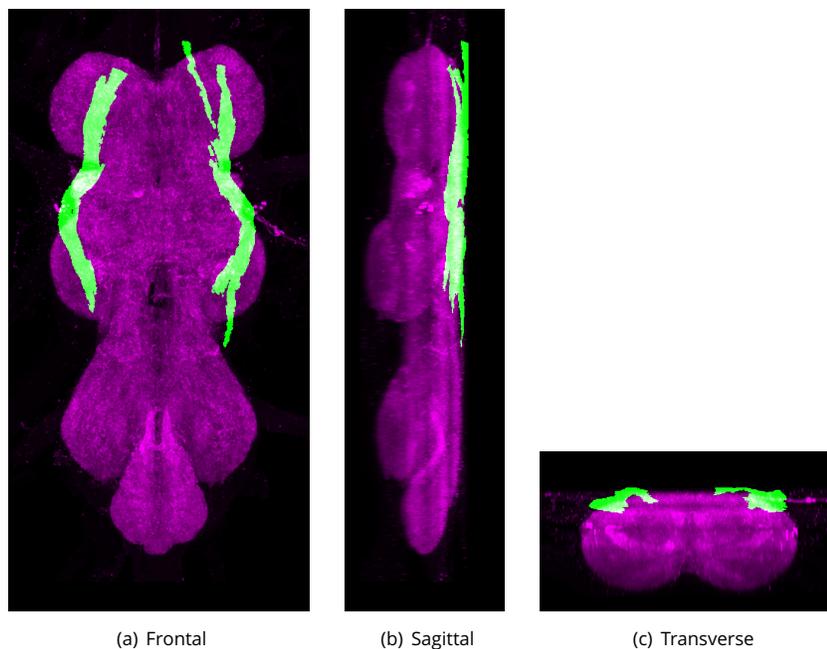
641 Dorsal Lateral Tract (DLT)

642 **Defined region shown in Appendix 1 Figure 8**

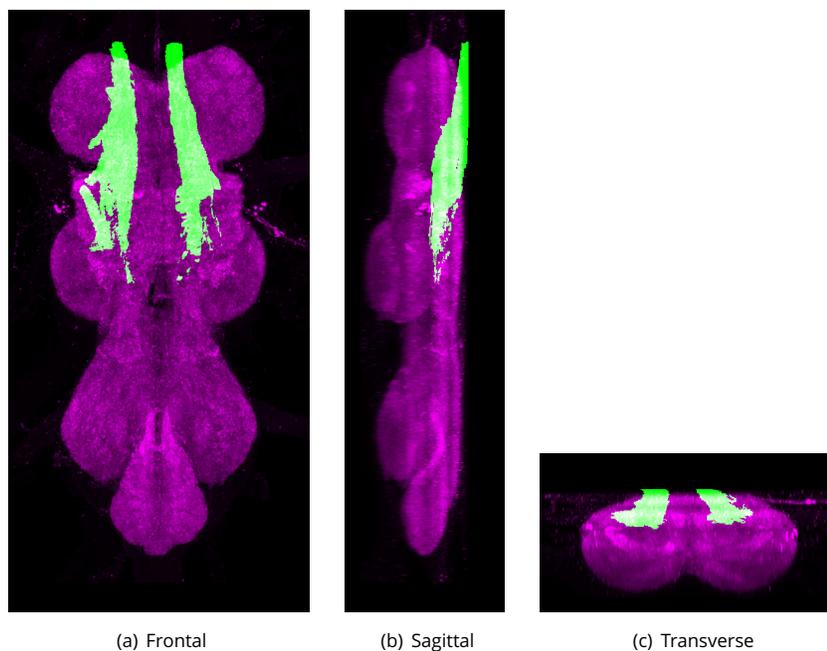
643 The DLT derives from the lateral bundles of the cervical connective. It has coarser fibres than  
644 the other tract derived from the ventral bundles of the cervical connective (DLV, VLT and VTV). The  
645 tract projects posteriorly and superficially at the dorsal lateral edge of the neuropil and terminates  
646 in the metathoracic neuromere.

647 **Synonyms:**

- 648 • DLT (*Power, 1948*)
- 649 • MTD (*Merritt and Murphey, 1992*),
- 650 • Median tract of dorsal cervical fasciculus (*Merritt and Murphey, 1992*).



**Appendix 1 Figure 8.** The proposed volume definition for the Dorsal Lateral Tract (DLT). Maximum projections from the labelled orthogonal plane with DLT shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on data provided by *Boerner and Duch (2010)* as well as literature and group discussions to clarify boundaries.



**Appendix 1 Figure 9.** The proposed volume definition for the Intermediate Tract of Dorsal Cervical Fasciculus (ITD). Maximum projections from the labelled orthogonal plane with ITD shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on data provided by *Boerner and Duch (2010)* as well as literature and group discussions to clarify boundaries.

651 Intermediate Tract of Dorsal Cervical Fasciculus (ITD)

652 **Defined region shown in Appendix 1 Figure 9**

653 The intermediate tracts of the dorsal fasciculus derive from the dorsal fibers in the connective  
654 but are much broader than the DLT and located more medial. The tract passes posteriorly, and  
655 tends to separate into three adjacent tracts. The inner subdivision (ITD-CFF) turns medially in the  
656 mesothoracic neuromere, crosses its homologue of the opposite side, and forms the chiasma of  
657 fine fibers of the intermediate tracts of the dorsal cervical fasciculus (CFF). The fibers of this chiasma  
658 pass dorsal to the median tracts of the dorsal fasciculus, and immediately over the very deep roots  
659 of the haltere nerves. Some of the fibers (ITD-HC) bend anterolaterally, while others turn ventrally  
660 and straggle into the dorsolateral part of the mesothoracic neuromere where they are quickly lost.  
661 There seems to be no consistency in which of the two bundles of the chiasma crosses above the  
662 other; sometimes the right tract passes above the left, and in other specimens the left is dorsal to  
663 the right, but in all cases, each tract retains its unity. In other words, the component elements of  
664 the two do not mix by intermeshing. The ITD as described by *Power (1948)* includes a third bundle  
665 of fibers (ITD-HT) that enter the VNS via the Dorsal Metathoracic Nerve (Haltere Nerve) and is the  
666 tract referred to as the Haltere Tract in *Merritt and Murphey (1992)*. This haltere tract is the most  
667 lateral component of the intermediate tract and is composed of many large-diameter fibres that  
668 can be traced as a bundle running into the cervical connective. It is composed of sensory afferent  
669 axons (*Ghysen, 1980; Strausfeld and Seyan, 1985*).

670 **Synonyms:**

- 671 • ITD (*Power, 1948*),
- 672 • ITD-HC NARROW (*Boerner and Duch, 2010*),
- 673 • ITD-CFF NARROW (*Boerner and Duch, 2010*),
- 674 • ITD-HT NARROW (*Boerner and Duch, 2010*).

675 Inner Tracts of the Intermediate Tract of the Dorsal Cervical Fasciculus (ITD-CFF)

676 **Defined region shown in Appendix 1 Figure 10**

677 An inner subdivision of the Intermediate tract of dorsal cervical fasciculus (ITD) that turns  
678 medially in the mesothoracic neuromere, crosses its homologue of the opposite side, and forms  
679 the chiasma of fine fibers of the intermediate tracts of the dorsal cervical fasciculus (CFF). The fibers  
680 of this chiasma pass dorsal to the median tracts of the dorsal fasciculus, and immediately over the  
681 very deep roots of the haltere nerves.

682 **Synonyms:**

- 683 • ITD-CFF (*Boerner and Duch, 2010*),
- 684 • CFF NARROW (*Power, 1948*),
- 685 • ITD BROAD (*Power, 1948*).

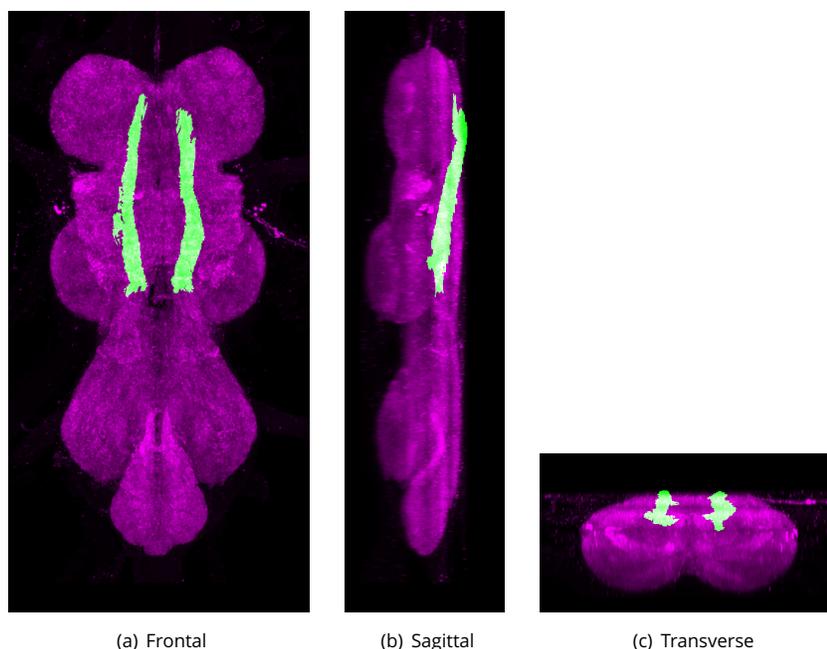
686 Haltere Tract (HT)

687 **Defined region shown in Appendix 1 Figure 11**

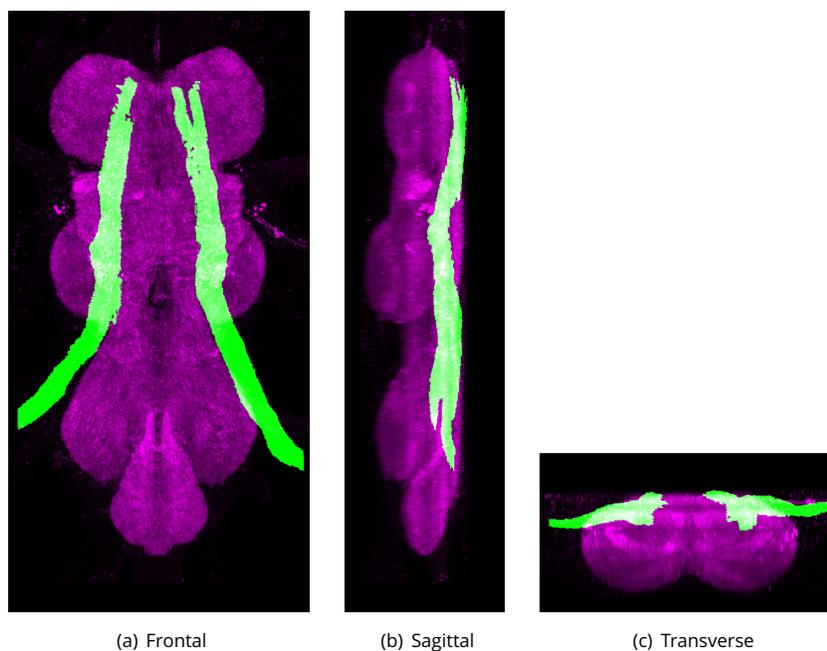
688 The haltere tract is formed by the sensory afferent axons (*Ghysen, 1980; Strausfeld and Seyan,*  
689 *1985*) from the dorsal metathoracic nerve (Haltere Nerve) entering the metathoracic neuromere  
690 and extending anteriorly through the cervical connective (*Power, 1948; Merritt and Murphey, 1992*).  
691 The tract has small arborizations with some of the fibres bending anterolaterally to become part  
692 of the haltere commissure (HC) in the metathoracic neuromere, while others turn ventrally and  
693 straggle into the dorsolateral part of the mesothoracic neuromere where they are quickly lost  
694 (*Power, 1948*). The haltere tract is the most lateral component of the intermediate tract (ITD) and is  
695 composed of many large-diameter fibres that can be traced as a bundle running into the cervical  
696 connective (*Power, 1948*).

697 **Synonyms:**

- 698 • ITD-HT (*Boerner and Duch, 2010*),



**Appendix 1 Figure 10.** The proposed volume definition for the Inner Tracts of the Intermediate Tract of the Dorsal Cervical Fasciculus (ITD-CFF). Maximum projections from the labelled orthogonal plane with ITD-CFF shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on data provided by *Boerner and Duch (2010)* as well as literature and group discussions to clarify boundaries.



**Appendix 1 Figure 11.** The proposed volume definition for the Haltere Tract (HT). Maximum projections from the labelled orthogonal plane with HT shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on data provided by *Boerner and Duch (2010)* as well as literature and group discussions to clarify boundaries.

- 699 • HT (*Merritt and Murphey, 1992*),
- 700 • ITD BROAD (*Power, 1948*).

#### 701 Dorsal Medial Tract (DMT)

##### 702 **Defined region shown in Appendix 1 Figure 12**

703 A tract which derives from the dorsal bundles of the cervical connective. The tract extends  
704 posteriorly and bows laterally slightly, in the mesothoracic region, bending again medially, towards  
705 each other, in the narrow area between the meso- and metathoracic neuromeres and passing  
706 ventrally to the chiasma of fine fibers. The dorsal medial tract turns lateroposteriorly at the level  
707 and dorsal to the haltere commissure, enters the metathoracic neuromere, forming collaterals and  
708 joins the metathoracic leg nerve (*Power, 1948*).

##### 709 **Synonyms:**

- 710 • MTD (*Power, 1948*),
- 711 • median tracts of the dorsal cervical connective (*Power, 1948*).

#### 712 Dorsal Lateral Tract of Ventral Cervical Fasciculus (DLV)

##### 713 **Defined region shown in Appendix 1 Figure 13**

714 A tract which derives from the ventral bundles of the cervical connective. It has coarser fibres  
715 than the ventral tract derived from the ventral bundles of the cervical connective (DLV, VLT and  
716 VTV). The tract spreads out as it extends posteriorly, passing dorsally to the commissure of the  
717 prothoracic neuromere, until it terminates in the mesothoracic neuromere. Two larger fibers occupy  
718 the lateral and medial borders of the tract. The lateral fibers send out a branch into the prothoracic  
719 neuromere, turn sharply posteriorly and enters the mesothoracic neuromere dorsally, producing a  
720 small median branch and joining the mesothoracic leg nerve. The medial fiber extends posteriorly  
721 until the level at which the giant fibers turn laterally, and turns slightly laterally into the mesothoracic  
722 neuromere. Ventral to these projections, the tract forms a fibrous loop (ventral ellipse) which runs  
723 from the prothoracic neuromere to the region between the meso- and metathoracic neuromeres.  
724 A right and left arm of fibers turn lateroposteriorly from the posterior end of the ellipse and join  
725 the metathoracic leg nerve. Ventral to the ellipse, fibers extend lateroanteriorly into the pro- and  
726 mesothoracic neuromeres.

##### 727 **Synonyms:**

- 728 • DLV (*Power, 1948*).

#### 729 Ventral Lateral Tract (VLT)

##### 730 **Defined region shown in Appendix 1 Figure 14**

731 A thin bundle of fibers which derives from the ventral bundles of the cervical connective. It  
732 is lateral to the ventral ellipse. The ventral lateral tract extends from the prothoracic neuromere  
733 posteriorly into the anterolateral sides of the metathoracic neuromere. At the level of the anterior  
734 dorsal mesothoracic nerve, the fibers bow sharply laterally but quickly turn medially and continue  
735 extending posteriorly, above the mesothoracic commissure (*Power, 1948*).

##### 736 **Synonyms:**

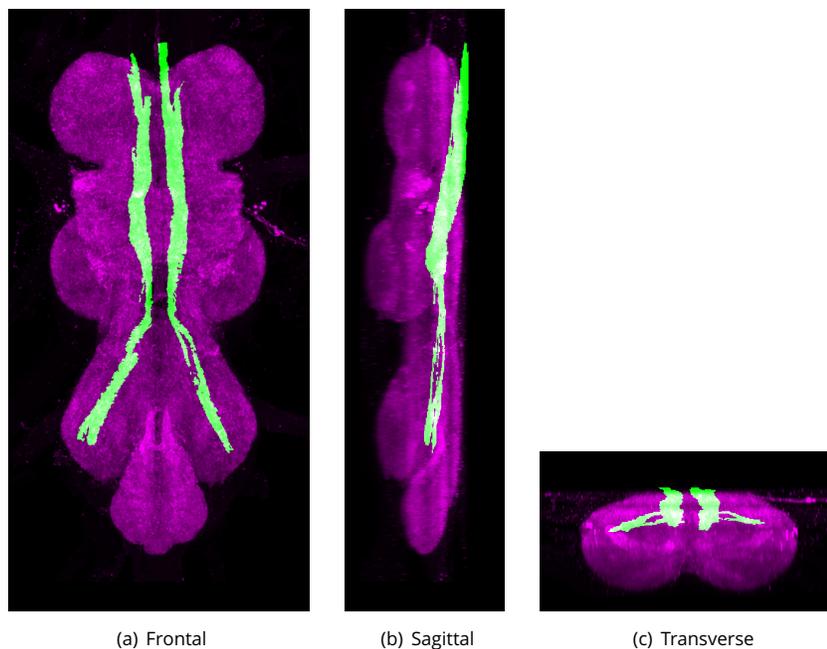
- 737 • ventral lateral tract of the ventral cervical fasciculus (*Power, 1948*),
- 738 • VLT (*Power, 1948*).

#### 739 Ventral Median Tract of Ventral Cervical Fasciculus (VTV)

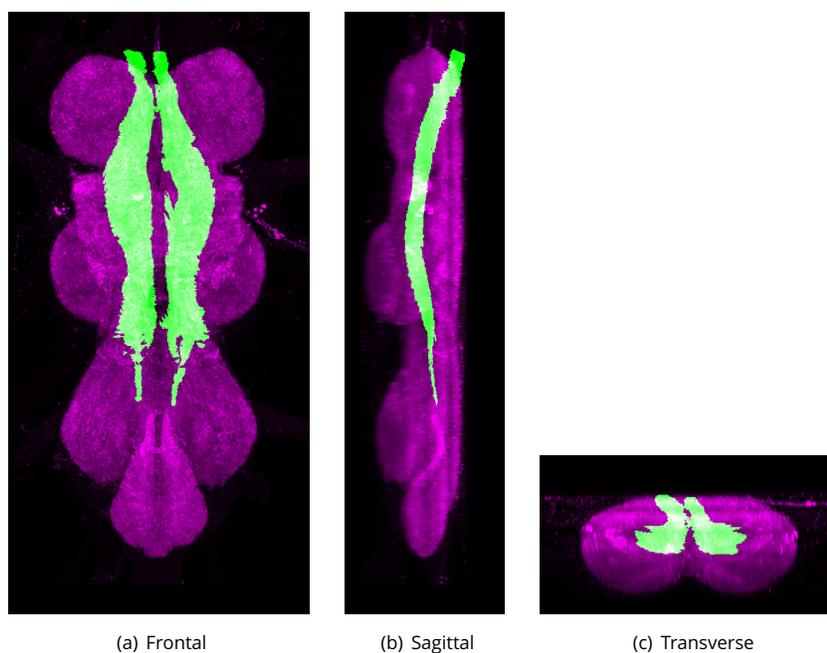
##### 740 **Defined region shown in Appendix 1 Figure 15**

741 A bundle of fine fibers which derives from the ventral bundles of the cervical connective.  
742 They extend posteriorly along the medial plane until they bend dorsally and terminate in the  
743 ventroanterior region of the abdominal ganglion. A few fibers branch out in each neuromere before  
744 the tract reaches the abdominal ganglion (*Power, 1948*).

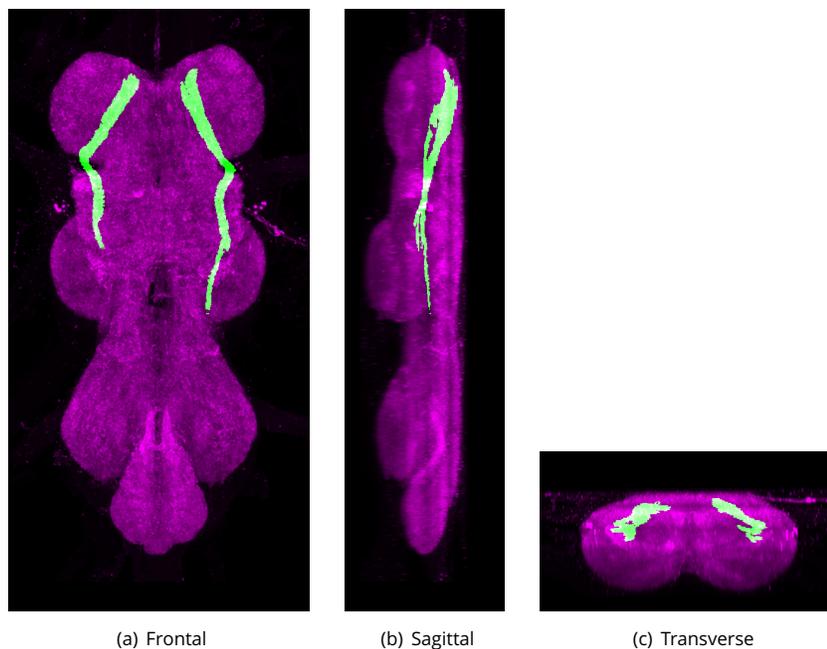
##### 745 **Synonyms:**



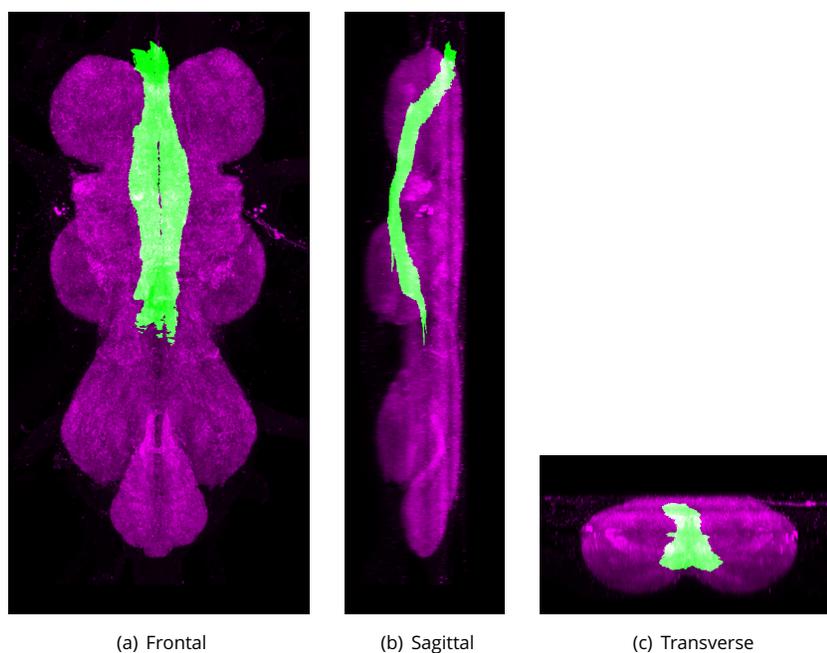
**Appendix 1 Figure 12.** The proposed volume definition for the Dorsal Medial Tract (DMT). Maximum projections from the labelled orthogonal plane with DMT shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on data provided by *Boerner and Duch (2010)* as well as literature and group discussions to clarify boundaries.



**Appendix 1 Figure 13.** The proposed volume definition for the Dorsal Lateral Tract of Ventral Cervical Fasciculus (DLV). Maximum projections from the labelled orthogonal plane with DLV shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on data provided by *Boerner and Duch (2010)* as well as literature and group discussions to clarify boundaries.



**Appendix 1 Figure 14.** The proposed volume definition for the Ventral Lateral Tract (VLT). Maximum projections from the labelled orthogonal plane with VLT shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on data provided by *Boerner and Duch (2010)* as well as literature and group discussions to clarify boundaries.



**Appendix 1 Figure 15.** The proposed volume definition for the Ventral Median Tract of Ventral Cervical Fasciculus (VTV). Maximum projections from the labelled orthogonal plane with VTV shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on data provided by *Boerner and Duch (2010)* as well as literature and group discussions to clarify boundaries.

746 • VTV (*Power, 1948*).

747 Median Dorsal Abdominal Tract (MDT)

748 **Defined region shown in Appendix 1 Figure 16**

749 The dorsal-most tract, close to midline (*Merritt and Murphey, 1992*) running along the tectulum  
750 (*Boerner and Duch, 2010*). The median-most pair of three small dorsal tracts which connects the  
751 thoracic and abdominal neuromeres. It runs from the dorsal region of the tectulum along through  
752 the thoraco-abdominal mass, immediately under the giant fibers. It continues posteriorly after the  
753 giant fibers have turned laterally, passing above the haltere chiasma into the abdominal neuromeres  
754 (*Power, 1948*).

755 **Synonyms:**

- 756 • MDT (*Merritt and Murphey, 1992*),
- 757 • MDA (*Power, 1948*),
- 758 • median dorsal tract (*Merritt and Murphey, 1992*).

759 Intermediate Dorsal Abdominal Tract (IDT)

760 The intermediate pair of three small dorsal tracts which connects the thoracic and abdominal  
761 neuromeres dorsal of the metathoracic neuromeres (*Power, 1948*).

762 **Synonyms:**

- 763 • IDT (Proposed by group).

764 Lateral Dorsal Abdominal Tract (LDT)

765 The lateral pair of three small dorsal tracts which connects the thoracic and abdominal neuromeres  
766 dorsal of the metathoracic neuromeres (*Power, 1948*).

767 **Synonyms:**

- 768 • LDT (Proposed by group).

769 Ventral Cervical Fasciculus (VCF)

770 Ventral fascicle of the dorsal tectulum. It enters the thoraco-abdominal mass along with the dorsal  
771 bundles and takes a more ventral course. There are two of these fascicles. Each fascicle passes  
772 posteriorly between the prothoracic and at an intermediate position in these neuromeres, dividing  
773 into the dorsal lateral (DLV) and ventral median (VTV) tracts (*Power, 1948*).

774 **Synonyms:**

- 775 • VCF (*Power, 1948*).

776 Dorsal Cervical Fasciculus (DCF)

777 Dorsal fascicle of the dorsal tectulum. It occupies the uppermost region within the anterior part of  
778 the dorsal tectulum. The fibers slope gently ventrally, so that by the time they have passed over the  
779 anterior tips of the mesothoracic neuromeres, they have descended to a relatively lower position,  
780 below the mesothoracic decussations. There are two of these fascicles. Near the anterior end of  
781 the VNS each of the dorsal fasciculus separates forming three poorly defined longitudinal tracts:  
782 the dorsal lateral (DLT), intermediate (ITD) and dorsal median tract (DMT) (*Power, 1948*).

783 **Synonyms:**

- 784 • DCF (*Power, 1948*).

785 Ventral Ellipse (VE)

786 Flattened annulus of fibers which lies in a frontal plane and extends from the middle of the protho-  
787 racic neuromeres posteriorly to the isthmus between the meso- and metathoracic neuromeres. It  
788 lies immediately below the dorsal decussations of the mesothoracic and metathoracic neuromeres.  
789 A right and left arm of fibers extends lateroposteriorly from the posterior end of the ellipse into the

790 respective metathoracic neuromeres, and within them, joins the bundle which runs out into the  
791 third leg nerve. At the anterior end, the ventral ellipse incorporates the dorsolateral tracts of the  
792 ventral fasciculi (DLV) (*Power, 1948*).

793 **Synonyms:**

- 794 • VE (*Power, 1948*).

795 **The peripheral nerves**

796 Most nerves have been historically well defined by *Power (1948)* in which case the definitions  
797 are maintained, however, with some of the abdominal nerves we decided to utilise later terms  
798 (*Shepherd and Smith, 1996*) naming each nerve according to its neuromere of origin to give them a  
799 more consistent naming scheme than the original.

800 **Cervical Connective (CvC)**

801 **Defined region shown in Appendix 1 Figure 17**

802 Major axon tract connecting the posterior-most subesophageal ganglion to the VNS in the adult  
803 central nervous system (*Power, 1948*).

804 **Synonyms:**

- 805 • CvC (*Power, 1948*),
- 806 • cephalo-thoracic cord (*Bodenstein, 1950*),
- 807 • cephalo-thoracic nerve strand,
- 808 • CC (*Merritt and Murphey, 1992*),
- 809 • CV (*Ito et al., 2014*),
- 810 • CvCon (*Miller and Demerec, 1950*).

811 **Cervical Nerve (CvN)**

812 A bilaterally paired nerve that connects laterally to the cervical connective, immediately posterior  
813 to where it enters the thorax. Each cervical nerve extends laterally, branching and innervating  
814 horizontal muscles of the anterior thorax (*Power, 1948*).

815 **Synonyms:**

- 816 • CvN (*Power, 1948*),
- 817 • nerve to crop (*Miller and Demerec, 1950*),
- 818 • CvNv (*Miller and Demerec, 1950*).

819 **Dorsal nerves directly innervating the neuropil of the prothoracic neuromere**

820 The dorsal prothoracic nerve, prosternal nerve, prothoracic chordotonal nerve, prothoracic ac-  
821 cessory nerve and the ventral prothoracic nerve emerge closely adjacent to each other in the  
822 anteriolateral corner of the prothoracic neuromere. Their proximity is such that in some prepara-  
823 tions they appear to share a common exit point.

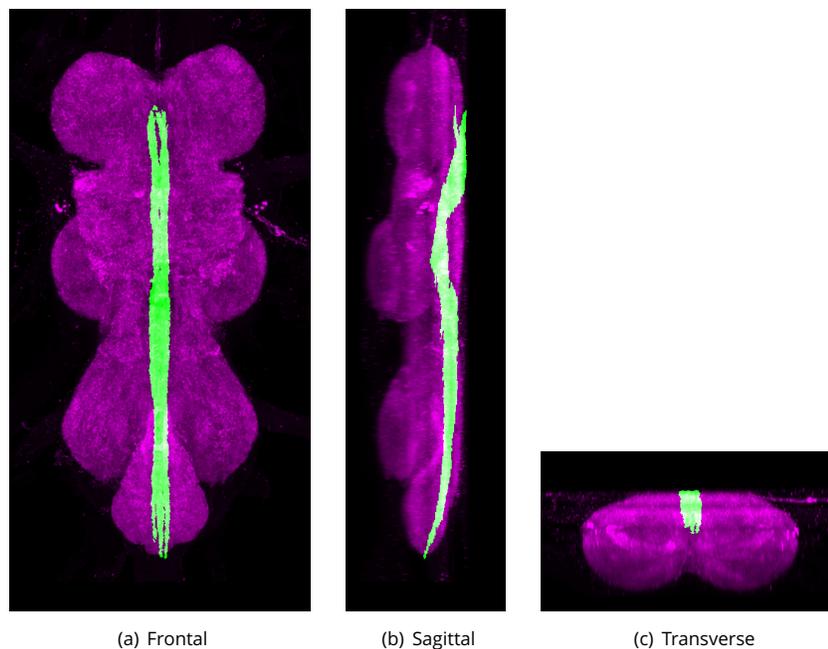
824 **Dorsal Prothoracic Nerve (DProN)**

825 **Defined region shown in Appendix 1 Figure 18**

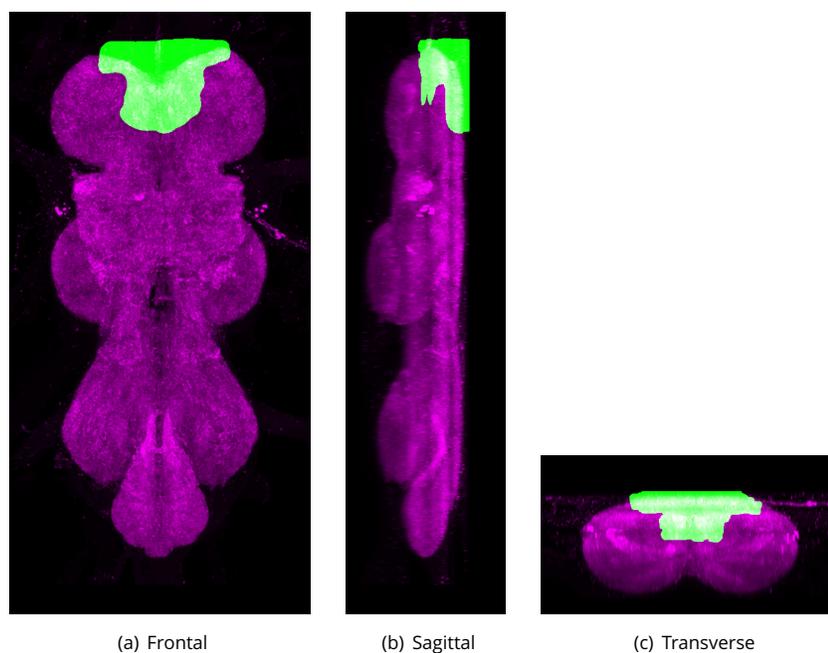
826 A nerve that projects latero-anteriorly from the antero-lateral corner of the ventral nervous  
827 system (VNS) (prothoracic neuromere). It splits into 4 or more branches before innervating various  
828 muscles (*Power, 1948*).

829 **Synonyms:**

- 830 • DProN (Proposed by group),
- 831 • ADN (*Power, 1948*),
- 832 • anterior dorsal nerve (*Power, 1948*),
- 833 • DPN (*Merritt and Murphey, 1992*),
- 834 • first dorsal nerve (*Miller and Demerec, 1950*),
- 835 • DNv1 (*Miller and Demerec, 1950*).



**Appendix 1 Figure 16.** The proposed volume definition for the Median Dorsal Abdominal Tract (MDT). Maximum projections from the labelled orthogonal plane with MDT shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on data provided by *Boerner and Duch (2010)* as well as literature and group discussions to clarify boundaries.



**Appendix 1 Figure 17.** The proposed volume definition for the Cervical Connective (CvC). Maximum projections from the labelled orthogonal plane with CvC shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.

836 Prosternal Nerve (PrN)

837 A slender nerve that projects anteriorly from the ventral nervous system (VNS), medial to the base  
838 of the dorsal prothoracic nerve to the prosternal sense organ (*Power, 1948*).

839 **Synonyms:**

- 840 • PrN (*Power, 1948*),
- 841 • PN (*Merritt and Murphey, 1992*).

842 Prothoracic Chordotonal Nerve (ProCN)

843 Very short and thick nerve that arises in the prothoracic neuromere, immediately below the anterior  
844 dorsal and prosternal nerves, and connects to each prothoracic chordotonal sense organ (*Power,*  
845 *1948*).

846 **Synonyms:**

- 847 • ProCN (Proposed by group),
- 848 • CN (*Power, 1948*).

849 Prothoracic Accessory Nerve (ProAN)

850 **Defined region shown in Appendix 1 Figure 19**

851 A mixed motor-sensory nerve that connects to the prothoracic neuromere, slightly posterior  
852 and ventral to the anterior prothoracic chordotonal organ and slightly dorsal to the root of the  
853 ventral prothoracic nerves. It extends laterally and dorsally almost to the lateral body wall before  
854 branching to innervate muscles (*Power, 1948*).

855 **Synonyms:**

- 856 • ProAN (Proposed by group),
- 857 • accessory prothoracic nerve,
- 858 • PAN (*Power, 1948*),
- 859 • first accessory nerve (*Miller and Demerec, 1950*),
- 860 • AcNv1 (*Miller and Demerec, 1950*).

861 Ventral Prothoracic Nerve (VProN)

862 **Defined region shown in Appendix 1 Figure 20**

863 A mixed motor-sensory nerve that carries axons from two clusters of microchaetae on the  
864 prothoracic coxa and to motor neuron fibers from lateral anterior muscles. It connects to the  
865 prothoracic neuromere just dorsal to the root of the prothoracic leg nerve and branches about  
866 halfway along its length into a motor branch that stays within the body and a sensory branch that  
867 projects to the leg (*Power, 1948*).

868 **Synonyms:**

- 869 • VProN (Proposed by group),
- 870 • VPN (*Power, 1948*),
- 871 • prosternal sense organ (*Miller and Demerec, 1950*),
- 872 • PSO (*Miller and Demerec, 1950*).

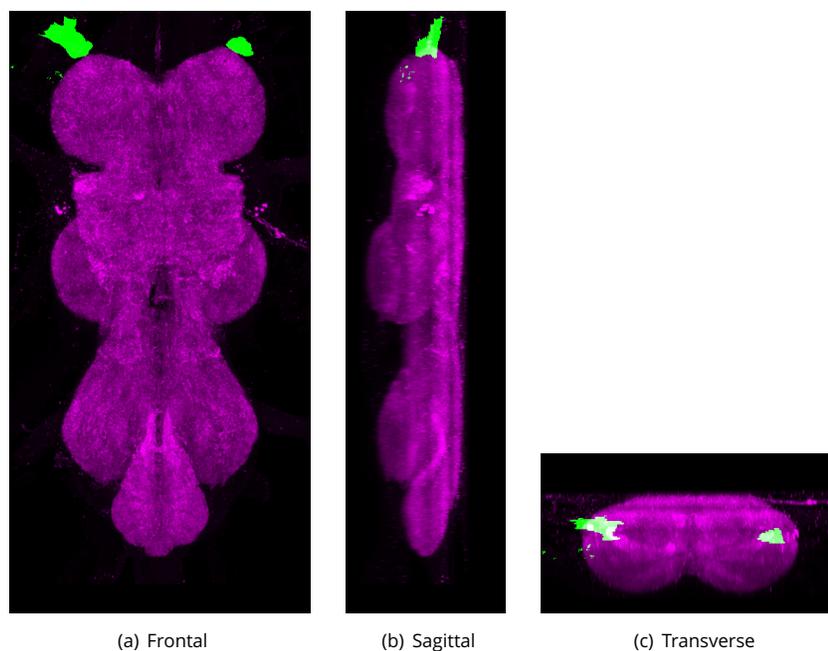
873 Prothoracic Leg Nerve (ProLN)

874 **Defined region shown in Appendix 1 Figure 21**

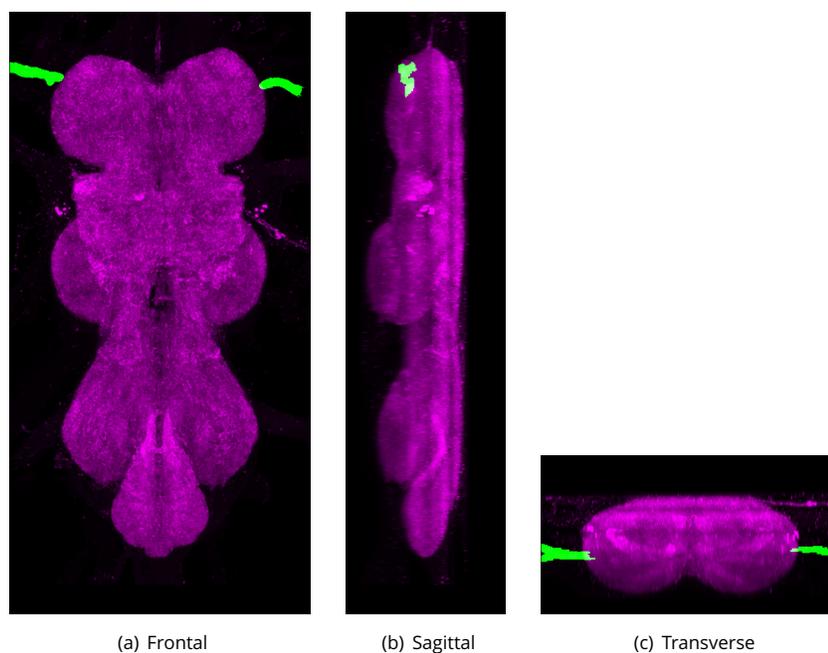
875 A nerve that carries a mix of motor and sensory axons from the prothoracic leg to the adult  
876 prothoracic neuromere. Each nerve extends laterally and slightly anteriorly from the ventral anterior  
877 region of the prothoracic neuromere (*Power, 1948*).

878 **Synonyms:**

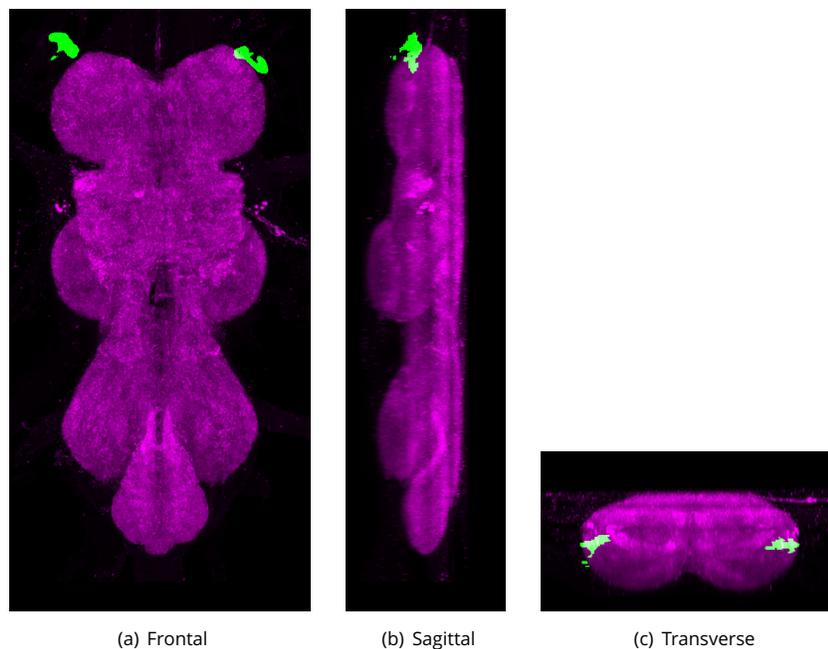
- 879 • ProLN (Proposed by group),
- 880 • PLN (*Power, 1948*),



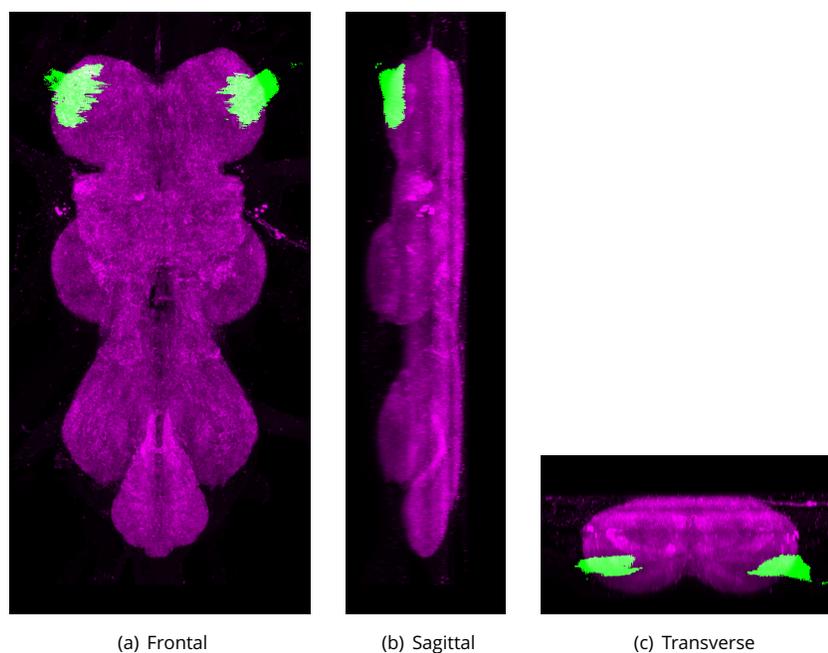
**Appendix 1 Figure 18.** The proposed volume definition for the Dorsal Prothoracic Nerve (DProN). Maximum projections from the labelled orthogonal plane with DProN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 19.** The proposed volume definition for the Prothoracic Accessory Nerve (ProAN). Maximum projections from the labelled orthogonal plane with ProAN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 20.** The proposed volume definition for the Ventral Prothoracic Nerve (VProN). Maximum projections from the labelled orthogonal plane with VProN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 21.** The proposed volume definition for the Prothoracic Leg Nerve (ProLN). Maximum projections from the labelled orthogonal plane with ProLN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.

- 881 • T1LN (*Merritt and Murphey, 1992*),  
882 • first ventral nerve (*Miller and Demerec, 1950*),  
883 • VNv1 (*Miller and Demerec, 1950*).

884 Anterior Dorsal Mesothoracic Nerve (ADMN)

885 **Defined region shown in Appendix 1 Figure 22**

886 A mixed sensory-motor nerve that is the thicker of the two dorsal nerves of the mesothorax.  
887 The nerve enters the mesothoracic neuromere slightly anterior and dorsal to the smaller PDMN.  
888 The ADMN projects anteriorly and dorsally (*Power, 1948*).

889 **Synonyms:**

- 890 • ADMN (*Power, 1948*),  
891 • second dorsal nerve BROAD (*Miller and Demerec, 1950*),  
892 • DNv2 BROAD (*Miller and Demerec, 1950*),  
893 • wing nerve BROAD (*Merritt and Murphey, 1992*).

894 Wing Nerve

895 A nerve that carries sensory fibers from the sense organs of the wing, eventually joining the anterior  
896 dorsal mesothoracic nerve (ADMN) (*Merritt and Murphey, 1992*).

897 Posterior Dorsal Mesothoracic Nerve (PDMN)

898 **Defined region shown in Appendix 1 Figure 23**

899 A nerve that arises from the ventral nervous system (VNS), just posterior to the root of the  
900 anterior dorsal mesothoracic nerve. It projects posterolaterally before branching, with one branch  
901 innervating the tergal depressor of the trochanter (jump muscle), while the other branch forms  
902 further, terminal branches that innervate targets including the dorsal medial muscle (dorsal longitu-  
903 dinal muscle) (*Power, 1948*).

904 **Synonyms:**

- 905 • PDMN (*Merritt and Murphey, 1992*),  
906 • PDM (*Power, 1948*)  
907 • second dorsal nerve BROAD (*Miller and Demerec, 1950*),  
908 • DNv2 BROAD (*Miller and Demerec, 1950*).

909 Mesothoracic Accessory Nerve (MesoAN)

910 **Defined region shown in Appendix 1 Figure 24**

911 A nerve that arises from the lateroposterior side of the mesothoracic neuromere at a point in  
912 anterior to the root of the haltere nerve. It extends posteriorly and slightly dorsally and laterally,  
913 around the anterior wings of the mesofurca, before branching. One branch innervates the furcoen-  
914 topleural muscles (muscles 59 and 60) and the other innervates laterally placed muscles, anterior  
915 to the halteres (*Power, 1948*).

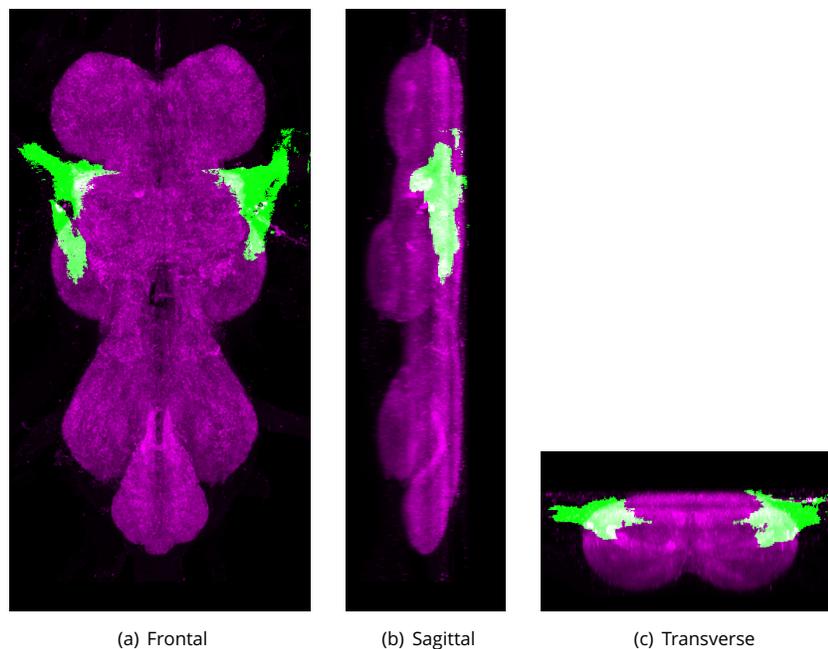
916 **Synonyms:**

- 917 • MesoAN (Proposed by group),  
918 • MAC (*Power, 1948*),  
919 • accessory mesothoracic nerve (*Power, 1948*)  
920 • second accessory nerve (*Miller and Demerec, 1950*),  
921 • AcNv2 (*Miller and Demerec, 1950*).

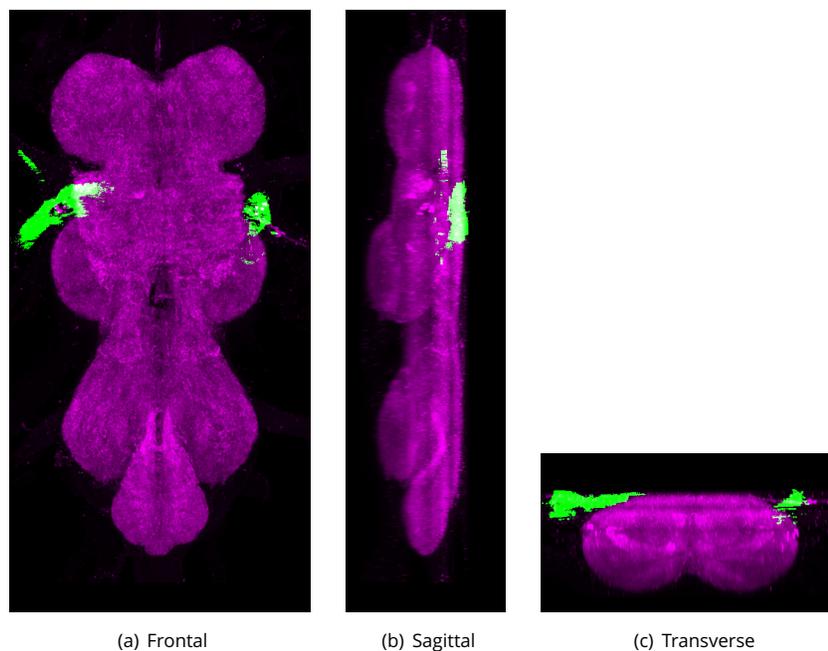
922 Mesothoracic Leg Nerve (MesoLN)

923 **Defined region shown in Appendix 1 Figure 25**

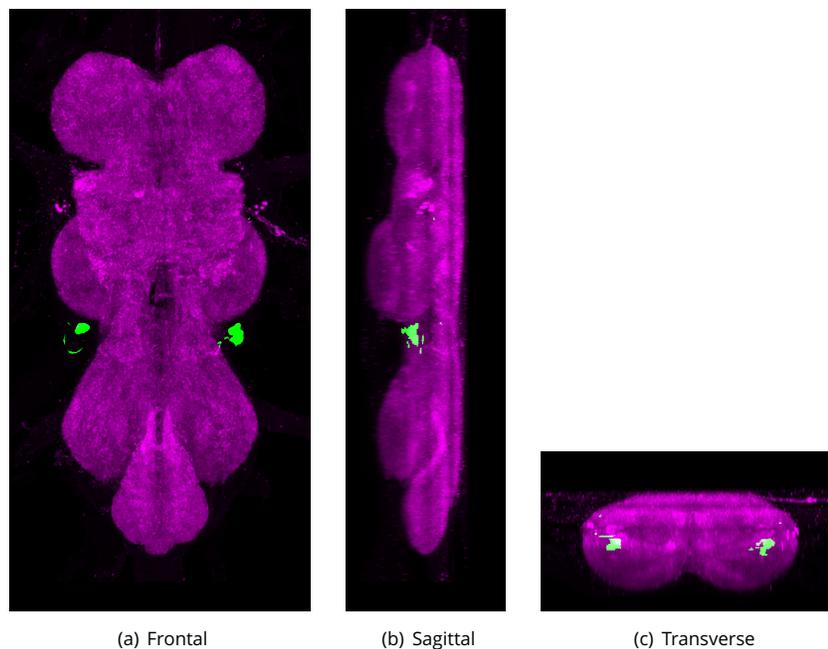
924 A mixed motor-sensory nerve that arises ventrally from the mesothoracic neuromere. It splits at  
925 its base, with a small number of axons innervating a ventral muscle that is posterior-lateral to the



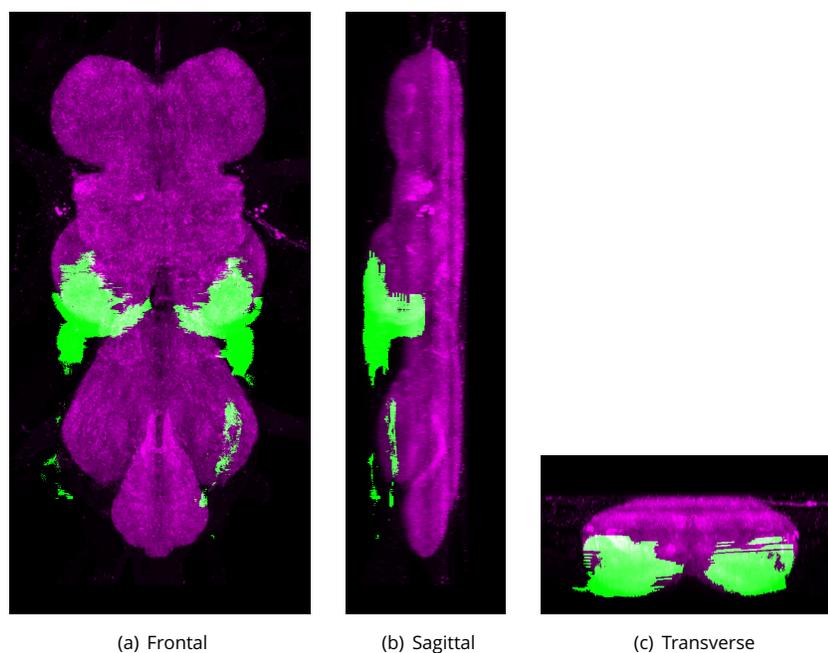
**Appendix 1 Figure 22.** The proposed volume definition for the Anterior Dorsal Mesothoracic Nerve (ADMN). Maximum projections from the labelled orthogonal plane with ADMN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 23.** The proposed volume definition for the Posterior Dorsal Mesothoracic Nerve (PDMN). Maximum projections from the labelled orthogonal plane with PDMN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 24.** The proposed volume definition for the Mesothoracic Accessory Nerve (MesoAN). Maximum projections from the labelled orthogonal plane with MesoAN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 25.** The proposed volume definition for the Mesothoracic Leg Nerve (MesoLN). Maximum projections from the labelled orthogonal plane with MesoLN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.

926 tergal depressor of the trochanter (jump muscle) and the rest projecting into the mesothoracic leg  
927 (*Power, 1948*).

928 **Synonyms:**

- 929 • MesoLN (Proposed by group),
- 930 • T2LN (*Merritt and Murphey, 1992*),
- 931 • second ventral nerve (*Miller and Demerec, 1950*),
- 932 • VNv2 (*Miller and Demerec, 1950*),
- 933 • ventral mesothoracic nerve.

934 Dorsal Metathoracic Nerve (DMetaN)

935 **Defined region shown in Appendix 1 Figure 26**

936 A thick nerve that primarily carries sensory axons from the haltere to the metathoracic neu-  
937 romere. It extends anteriorly and somewhat medially to terminate in the center of the metathoracic  
938 neuromere. Its fibers extend anteriorly, contributing to the tectulum (*Power, 1948*).

939 **Synonyms:**

- 940 • DMetaN (Proposed by group),
- 941 • haltere nerve (*Power, 1948*),
- 942 • HN (*Power, 1948*),
- 943 • third dorsal nerve (*Miller and Demerec, 1950*),
- 944 • DNv3 (*Miller and Demerec, 1950*).

945 Metathoracic Leg Nerve (MetaLN)

946 **Defined region shown in Appendix 1 Figure 27**

947 A large sensory motor nerve that originates in the ventral metathoracic neuromere and inner-  
948 vates the metathoracic leg (*Power, 1948*).

949 **Synonyms:**

- 950 • MetaLN (Proposed by group),
- 951 • MLN (*Power, 1948*),
- 952 • T3LN (*Merritt and Murphey, 1992*),
- 953 • third ventral nerve (*Miller and Demerec, 1950*),
- 954 • VNv3 (*Miller and Demerec, 1950*),
- 955 • ventral metathoracic nerve.

956 **The abdominal nerves**

957 Emerging from the abdominal neuromeres are four paired nerves that extend posteriorly and  
958 laterally into the abdomen.

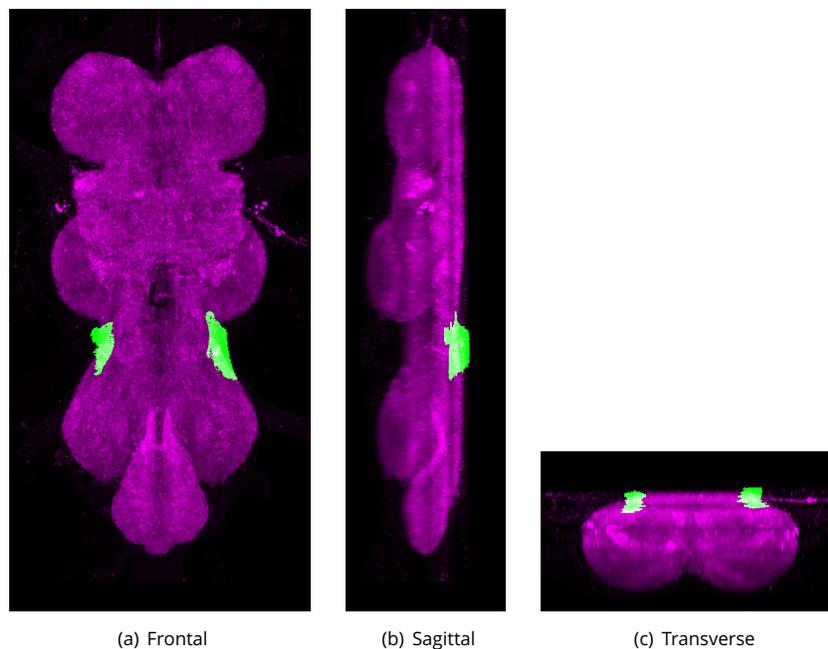
959 First Abdominal Nerve (AbN1)

960 **Defined region shown in Appendix 1 Figure 28**

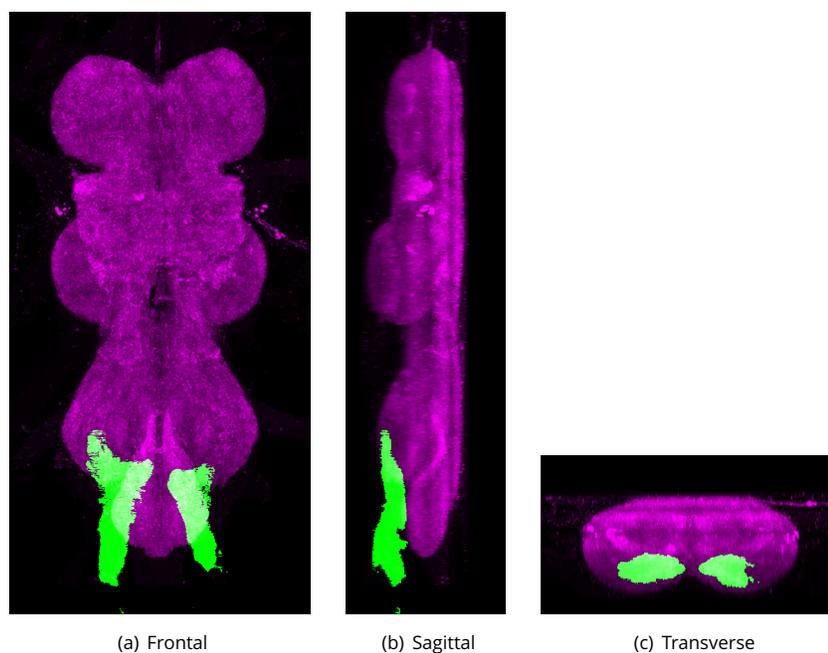
961 The first abdominal nerve apparently emerges from the metathoracic neuromere but contains  
962 axons that originate/terminate in the first abdominal neuromere. The nerve exits laterally just  
963 dorsal to the exit of the metathoracic leg nerve (*Shepherd and Smith, 1996*).

964 **Synonyms:**

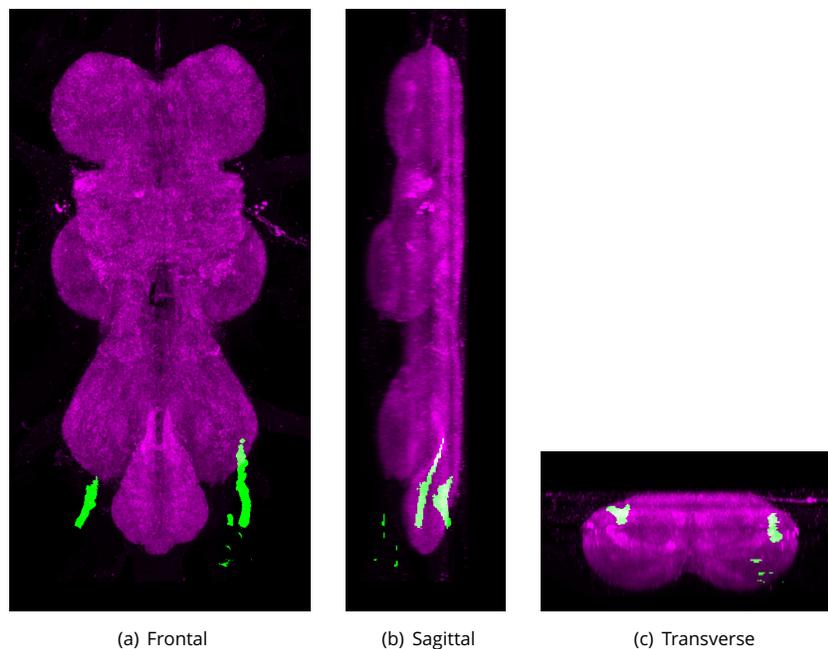
- 965 • AbN1 (*Shepherd and Smith, 1996*),
- 966 • accessory metathoracic nerve,
- 967 • MA (*Power, 1948*),
- 968 • metathoracic accessory nerve (*Power, 1948*),
- 969 • nerve of the first abdominal segment (*Miller and Demerec, 1950*),
- 970 • Ab1Nv (*Miller and Demerec, 1950*).



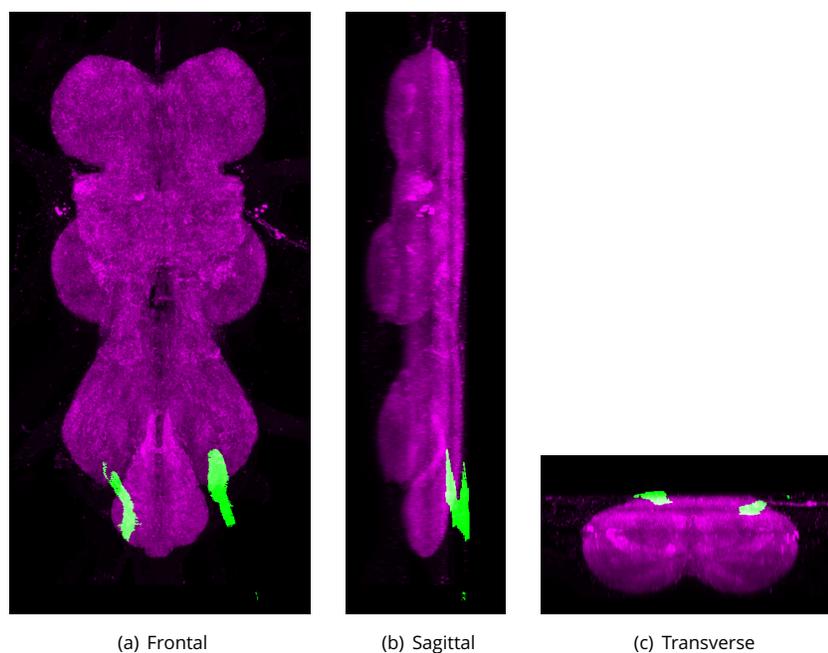
**Appendix 1 Figure 26.** The proposed volume definition for the Dorsal Metathoracic Nerve (DMetaN). Maximum projections from the labelled orthogonal plane with DMetaN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 27.** The proposed volume definition for the Metathoracic Leg Nerve (MetaLN). Maximum projections from the labelled orthogonal plane with MetaLN shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 28.** The proposed volume definition for the First Abdominal Nerve (AbN1). Maximum projections from the labelled orthogonal plane with AbN1 shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 29.** The proposed volume definition for the Second Abdominal Nerve (AbN2). Maximum projections from the labelled orthogonal plane with AbN2 shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.

971 Second Abdominal Nerve (AbN2)

972 **Defined region shown in Appendix 1 Figure 29**

973 A nerve that apparently emerges in the dorsal-most region of the metathoracic neuromere but  
974 contains axons that originate/terminate in the second abdominal neuromere. The nerve projects  
975 postero-laterally to the most posterior-lateral corner of the thorax, where it innervates transverse  
976 tubular muscles. This nerve also contains the afferent fibers from a multiscolophorous organ  
977 located on the ventral surface of the second abdominal segment (*Shepherd and Smith, 1996*).

978 **Synonyms:**

- 979 • AbN2 (*Shepherd and Smith, 1996*),
- 980 • extra metathoracic nerve (*Power, 1948*),
- 981 • EMN (*Power, 1948*),
- 982 • nerve of the second abdominal segment (*Miller and Demerec, 1950*),
- 983 • Ab2Nv (*Miller and Demerec, 1950*).

984 Third Abdominal Nerve (AbN3)

985 **Defined region shown in Appendix 1 Figure 30**

986 Lateral-most of the two bilaterally paired nerves connected to the abdominal neuropil. It is thin,  
987 containing only fine fibers (*Shepherd and Smith, 1996*).

988 **Synonyms:**

- 989 • AbN3 (*Shepherd and Smith, 1996*),
- 990 • first lateral abdominal nerve (*Power, 1948*),
- 991 • FLA (*Power, 1948*),
- 992 • nerve of the third abdominal segment (*Miller and Demerec, 1950*),
- 993 • Ab3Nv (*Miller and Demerec, 1950*).

994 Fourth Abdominal Nerve (AbN4)

995 **Defined region shown in Appendix 1 Figure 31**

996 Medial-most of the two bilaterally paired nerves connected to the abdominal neuropil. It is thin,  
997 containing only fine fibers (*Shepherd and Smith, 1996*).

998 **Synonyms:**

- 999 • AbN4 (*Shepherd and Smith, 1996*),
- 1000 • second lateral abdominal nerve (*Power, 1948*),
- 1001 • SLA (*Power, 1948*),
- 1002 • nerve of the fourth abdominal segment (*Miller and Demerec, 1950*),
- 1003 • Ab4Nv (*Miller and Demerec, 1950*).

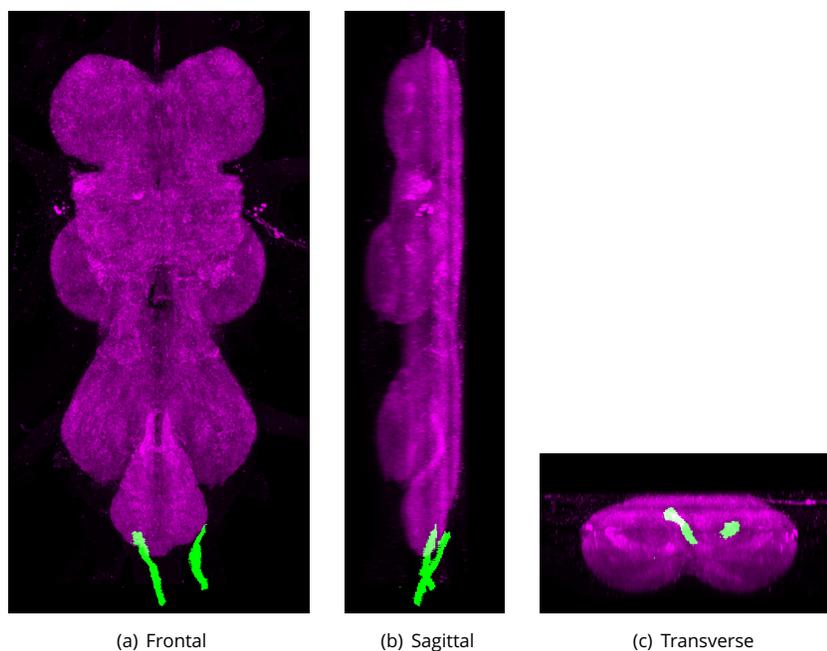
1004 Abdominal Nerve Trunk (AbNT)

1005 **Defined region shown in Appendix 1 Figure 32**

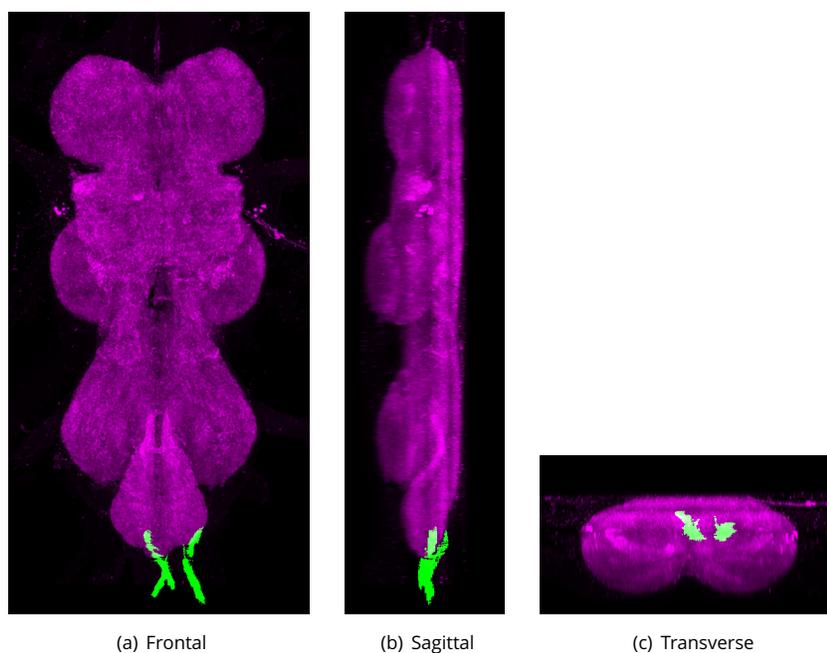
1006 A fused terminal nerve that projects posteriorly along the midline from the posterior of the  
1007 abdominal neuropil (*Shepherd and Smith, 1996*).

1008 **Synonyms:**

- 1009 • AbNT (*Shepherd and Smith, 1996*),
- 1010 • abdominal median nerve trunk,
- 1011 • median nerve trunk (*Middleton et al., 2006*),
- 1012 • AbNvTr (*Middleton et al., 2006*),
- 1013 • MAN (*Power, 1948*),
- 1014 • median abdominal nerve (*Power, 1948*),
- 1015 • terminal abdominal nerves (*Miller and Demerec, 1950*),
- 1016 • AbTNv (*Miller and Demerec, 1950*).



**Appendix 1 Figure 30.** The proposed volume definition for the Third Abdominal Nerve (AbN3). Maximum projections from the labelled orthogonal plane with AbN3 shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.



**Appendix 1 Figure 31.** The proposed volume definition for the Fourth Abdominal Nerve (AbN4). Maximum projections from the labelled orthogonal plane with AbN4 shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.

1017 **Individual Neurons**

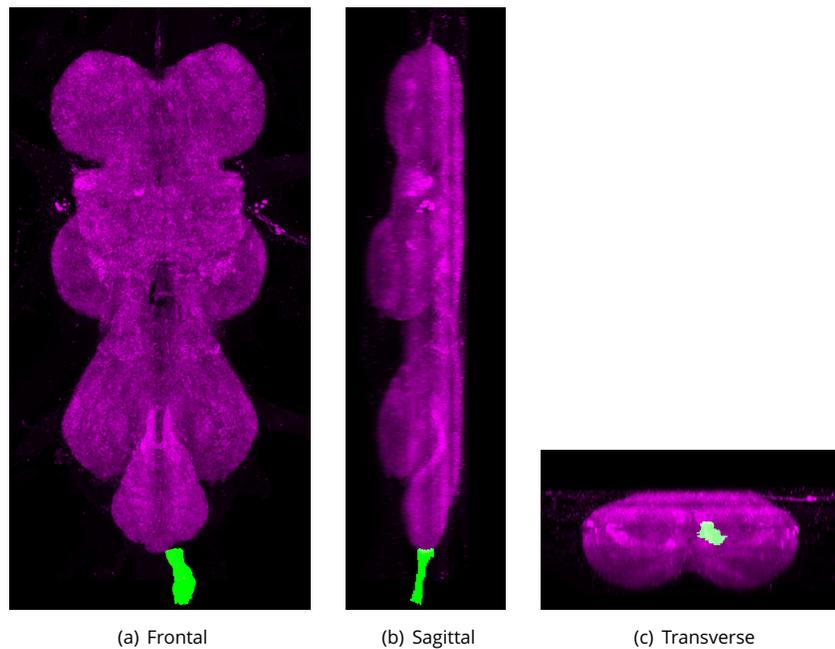
1018 Whilst we did not want to expand our remit to cover individual neurons in this first consolidation  
1019 we thought it would be a good idea to include an example to demonstrate how easily this could be  
1020 done.

1021 **Giant Fiber Neuron (GF)**

1022 A large, descending neuron that controls jump escape behaviour (*Trimarchi and Schneiderman,*  
1023 *1993*). Each adult has a bilaterally symmetric pair of these neurons, each with a large cell body  
1024 at the posterior of the protocerebrum and a long primary neurite that branches to form an  
1025 extensive dendritic tree in the brain and an axon that projects, via the cervical connective, to the  
1026 mesothorax. The axon enters the ventral nervous system (VNS) on the dorsal region and slopes  
1027 ventrally, reaching the ventral mesothoracic neuromere. Targets of dendritic arborization include  
1028 zone A of the antennal mechanosensory and motor center (AMMC) (*Kamikouchi et al., 2009*) and  
1029 the inferior ventro-lateral protocerebrum. In the mesothorax, the axon forms electrical synapses  
1030 with tergotrochanteral muscle motor neuron (TTMn) and peripherally synapsing interneurons (PSI)  
1031 of the mesothorax that in turn synapse to the motor neurons of the dorso-longitudinal flight  
1032 muscles.

1033 **Synonyms:**

- 1034 • GF (*Power, 1948*),
- 1035 • giant fiber (*Power, 1948*),
- 1036 • GFN (*Kamikouchi et al., 2009*),
- 1037 • giant fibers.



**Appendix 1 Figure 32.** The proposed volume definition for the Abdominal Nerve Trunk (AbNT). Maximum projections from the labelled orthogonal plane with AbNT shown in green and neuropil (Bruchpilot) shown in magenta. Regions were painted using ITK-SNAP by Robert Court based on literature and group discussions to clarify boundaries.