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Blain, H.-A., et al., 2019, Latest Villafranchian climate and landscape reconstructions at Pirro Nord (southern Italy): Geology, https://doi.org/10.1130/G46392.1

# DATA REPOSITORY ITEM

## APPENDIX DR1: SUPPLEMENTARY INFORMATION ON THE GEOLOGICAL AND BIOCHRONOLOGICAL ATTRIBUTION OF PIRRO NORD

The Early Pleistocene fossil vertebrates from Pirro Nord (PN, a locality also known as Cava Pirro or Cava Dell'Erba) were discovered in the early 1970s during fieldwork campaigns by the NCB/Naturalis Museum of Leiden (The Netherlands) looking at Late Miocene vertebrates (Freudenthal, 1971). The locality (41°48′07″N, 15°23′05″E) lies in the municipality of Apricena, near Foggia, in one of the quarries exploiting the Mesozoic Calcare di Bari Fm. The paleontological record at PN is preserved inside a karstic network at the top of the Mesozoic limestones, infilled with continental sediments that often contain numerous vertebrate remains and which represent highly diversified paleocommunities (Abbazzi et al., 1996; Pavia et al., 2010).

The PN vertebrate assemblage comprises 23 amphibian and reptile taxa (Delfino and Bailon, 2000; Delfino and Atzori, 2013; Blain et al., 2016), 47 birds (Bedetti, 2003), and over 40 mammals (Abbazzi et al., 1996; Rook, 2013). These vertebrate assemblages have been recovered from different sites, but they are considered almost contemporaneous from a biochronological point of view, based on the evolutionary degrees of the analyzed taxa (Arzarello et al., 2007). The fossils refer to a homogeneous vertebrate fauna from the late Early Pleistocene that, more precisely, represents the last Faunal Unit (Pirro Nord FU or Pirro FU) of the Late Villafranchian Mammal Age in the Italian biochronological scale (Gliozzi et al., 1997; Rook and Martínez-Navarro, 2010). The most important bioevents characterizing the Pirro FU are the first occurrence of *Equus altidens*, *Bison degiulii*, and *Xenocyon lycaonoides*. Moreover, the Pirro FU represents the last occurrence of some taxa of an earlier origin, such as *Megantherion whitei* and *Hystrix refossa*. Additional information derives from the study of the evolutionary degree of the arvicoline species *Allophaiomys ruffoi* (López-García et al., 2015). The Pirro FU is also characterized by one of the first European occurrence of the genus *Homo*, as indicated by the rich lithic tool record documented from Pirro 13 (Arzarello et al., 2007, 2009, 2015; Arzarello and Peretto, 2010).

From a geochronological point of view, the Pirro FU has been attributed to an interval between 1.3 and 1.7 Ma (Arzarello et al., 2009), although not all authors agree with this date (other suggestions include: 1.2-1.5 Ma, according to Masini and Sala, 2007; and 1.3-1.5 Ma, according to Bertini et al., 2010), and it can be related to other European faunal assemblages such as those from Venta Micena (Spain) (Rook and Martínez-Navarro, 2010). The biochronological attribution of PN is further constrained by paleomagnetism, with negative magnetization relating to the Matuyama post-Olduvai Chron, with a date not much younger than 1.7 Ma (Napoleone et al., 2003).

**APPENDIX DR2: SUPPLEMENTARY INFORMATION ON THE HERPETOFAUNAL ASSEMBLAGES FROM THE PIRRO NORD FISSURES: QUANTITATIVE DATA USED FOR HABITAT WEIGHTING**

**Table DR1:** Distribution of amphibians and reptiles from the Pirro Nord fissures according to the number of identifiable skeletal parts (NISP) and the minimum number of individuals (MNI). In grey are identified the assemblages that have been discarded for paleoenvironmental and paleoclimatic reconstruction due to the low amount of remains and/or taxa.

| | | *Bufotes viridis* s.l. | *Bufo bufo* | Bufonidae indet. | *Pelophylax esculentus/ridibundus* | *Pelophylax* sp. | *Hyla* gr. *H. arborea* | Anura indet. | *Testudo* gr. *T. hermanni* | *Emys orbicularis* | *Mauremys* sp. | Emydidae indet. | Testudines indet. | *Podarcis* sp. | *Lacerta* s.l. | Lacertilia indet. | *Hierophis viridiflavus* | *Zamenis longissimus* | *Coronella* cf. *C. austriaca* | Colubrines indet. | *Natrix natrix* | Ophidia indet. | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PN1 | NISP | 2 | 11 | 13 | 2 | 9 | 2 | 3 | 99 | 14 | | 1 | 180 | 5 | 48 | 1 | 13 | | | 6 | 15 | 17 | 441 |
| | MNI | 1 | 2 | | 2 | 2 | 1 | | 6 | 3 | | | | 2 | 5 | | 1 | | | | 1 | | 26 |
| PN2 | NISP | | | 3 | | 31 | | | 12 | 51 | 3 | 3 | 33 | 8 | 8 | 12 | | | | | | 1 | 165 |
| | MNI | | | | | 14 | | | 1 | 3 | 2 | | | 3 | 3 | | | | | | | | 26 |
| PN5 | NISP | | | | | | | | 47 | 11 | | | 21 | 102 | | 22 | 2 | 1 | | 10 | 3 | 3 | 222 |
| | MNI | | | | | | | | 4 | 2 | | | | 19 | | | 1 | 1 | | | 1 | | 28 |
| PN5b | NISP | | 1 | | | 11 | | | 6 | | | 1 | 10 | 23 | 76 | 24 | | | | | | | 152 |
| | MNI | | 1 | | | 5 | | | 2 | | | | 3 | 4 | 15 | | | | | | | | 30 |
| PN6 | NISP | | | | | | | | | | | | | | 2 | 3 | | | | | | | 5 |
| | MNI | | | | | | | | | | | | | | 1 | | | | | | | | 1 |
| PN9 | NISP | | 5 | 1 | 1 | 18 | | | 4 | | | 1 | 5 | 9 | 19 | 7 | 14 | 4 | 3 | | 4 | 13 | 108 |
| | MNI | | 1 | | 1 | 6 | | | 1 | | | | | 4 | 4 | | 1 | 1 | 1 | | 1 | | 21 |
| PN11 | NISP | | 1 | 2 | | | 1 | | 61 | | 8 | 9 | 34 | 44 | 2 | 5 | | 3 | | 10 | | 1 | 181 |
| | MNI | | 1 | | | | 1 | | 4 | | 2 | | | 12 | 2 | | | 1 | | | | | 23 |
| PN11 spb | NISP | | | 1 | | | | | | | 4 | 1 | | | | | | | | 2 | | 2 | 10 |
| | MNI | | | | | | | | | | 1 | | | | | | | | | | | | 1 |
| PN12 | NISP | 2 | | | | | | | 2 | | | | | 36 | 1 | 1 | | | | | | | 42 |
| | MNI | 2 | | | | | | | 1 | | | | | 17 | 1 | | | | | | | | 21 |
| PN15 | NISP | | | | | | | | | | | | 1 | 14 | 2 | | | | | | | | 17 |
| | MNI | | | | | | | | | | | | | 9 | 2 | | | | | | | | 11 |
| PN16 | NISP | | 2 | 2 | 1 | 1 | | | 2 | 1 | | 2 | 9 | 4 | 26 | | 2 | 2 | | 15 | 2 | 4 | 75 |
| | MNI | | 1 | | 1 | 1 | | | 1 | 1 | | | | 2 | 2 | | 1 | 1 | | | 1 | | 12 |
| PN17 | NISP | | 3 | | | 7 | | | 1 | | | 1 | 6 | 12 | 26 | 3 | 1 | | | 6 | 1 | 2 | 69 |
| | MNI | | 1 | | | 4 | | | 1 | | | | | 7 | 5 | | 1 | | | | 1 | | 20 |
| PN18 | NISP | | | | | | | | | | | | | 2 | 1 | | | | | 1 | | | 4 |
| | MNI | | | | | | | | | | | | | 2 | 1 | | | | | | | | 3 |
| PN22 err | NISP | | | | | 1 | | | 3 | 1 | | | | | | | | | | 2 | | 2 | 9 |
| | MNI | | | | | 1 | | | 1 | 1 | | | | | | | | | | | | | 3 |
| PN22 sacca | NISP | | | | | | | | 2 | | | | 3 | | | | | | | | | | 5 |
| | MNI | | | | | | | | 1 | | | | | | | | | | | | | | 1 |
| PN22 | NISP | | | | | | | | | | | | | | 1 | | | | | | | 1 | 2 |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| in posto | | | | | | | | | | | | | | | | | | | | | | | | |
| | MNI | | | | | | | | | | | | | | 1 | | | | | | | | | 1 |
| PN22 bis | NISP | | | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| | MNI | | | | | | | | | | | | | | | | | | | | | | | 0 |
| PN24 | NISP | | | | | | | | | | | | | | | | | | | 2 | 1 | | | 3 |
| | MNI | | | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| PN24b | NISP | | | 3 | | | | | | | | | | | | | | | | 4 | | | | 7 |
| | MNI | | | | | | | | | | | | | | | | | | | | | | | 0 |
| PN25 | NISP | | | | | 5 | | | 3 | | | | | 5 | 4 | | | | | 1 | | 1 | | 19 |
| | MNI | | | | | 1 | | | 1 | | | | | 3 | 2 | | | | | | | | | 7 |
| PN26 | NISP | | | | | | | | 5 | 3 | | 1 | 3 | 13 | 6 | 1 | | | | | | 1 | | 33 |
| | MNI | | | | | | | | 2 | 1 | | | | 6 | 2 | | | | | | | | | 11 |
| PN30 | NISP | | | | | | | | | | | | | 7 | | 1 | | | | | | | | 8 |
| | MNI | | | | | | | | | | | | | 4 | | | | | | | | | | 4 |
| PN32 | NISP | | | | | | | | 3 | 2 | | | | | | | | | | | | | | 5 |
| | MNI | | | | | | | | 1 | 1 | | | | | | | | | | | | | | 2 |
| PN34 err | NISP | | | | | | | | | | | | | 2 | 1 | 1 | | | | | | | | 4 |
| | MNI | | | | | | | | | | | | | 2 | 1 | | | | | | | | | 3 |
| PN34a | NISP | | | | | 3 | | | 17 | | | | 3 | 35 | | 1 | | | | | | 1 | | 60 |
| | MNI | | | | | 1 | | | 2 | | | | | 14 | | | | | | | | | | 17 |
| PN34c | NISP | | | | | | | | | | | | | 14 | 2 | 2 | | | | | | 1 | | 19 |
| | MNI | | | | | | | | | | | | | 5 | 1 | | | | | | | | | 6 |
| PN34d | NISP | | | 1 | | | | | | | | | | 23 | 1 | | | | | | | | | 25 |
| | MNI | | | | | | | | | | | | | 11 | 1 | | | | | | | | | 12 |
| PN35 | NISP | | | | | | | | 4 | | | 1 | 1 | 4 | | | | | | | | | | 10 |
| | MNI | | | | | | | | 1 | | | | | 3 | | | | | | | | | | 4 |
| TOTAL | NISP | 4 | 23 | 26 | 4 | 86 | 3 | 3 | 271 | 83 | 15 | 21 | 309 | 362 | 226 | 84 | 32 | 10 | 3 | 60 | 26 | 50 | | 1701 |
| | MNI | 3 | 7 | 0 | 4 | 35 | 2 | | 30 | 12 | 5 | | 3 | 129 | 49 | 0 | 5 | 4 | 1 | | 6 | | | 295 |

## APPENDIX DR3: SUPPLEMENTARY INFORMATION ON THE HERPETOFAUNAL ASSEMBLAGES FROM THE PIRRO NORD FISSURES: ABSENCE/PRESENCE MATRIX USED FOR STATISTICAL ANALYSIS

**Table DR2:** Data matrix of presence (1) and absence (0) for 24 Cava Pirro sites from the Pirro Nord karstic complex. Monospecific sites, such as PN11 spb, PN22 sacca, PN22 bis, and PN24b (Delfino, 1996; Delfino and Bailon, 2000), have been excluded from the data matrix, to avoid statistical deviations.

| | PN1 | PN2 | PN5 | PN5b | PN6 | PN9 | PN11 | PN12 | PN15 | PN16 | PN17 | PN18 | PN22err | PN22 in posto | PN24 | PN25 | PN26 | PN30 | PN32 | PN34err | PN34a | PN34c | PN34d | PN35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Bufotes viridis* s.l. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Bufo bufo* | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pelophylax* sp. | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Hyla* gr. *H. arborea* | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Testudo* gr. *T. hermanni* | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| *Emys orbicularis* | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Mauremys* sp. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Podarcis* sp. | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| *Lacerta* s.l. | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| *Hierophis viridiflavus* | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Zamenis longissimus* | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Coronella* cf. *C. austriaca* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Natrix natrix* s.l. | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## APPENDIX DR4: ACTUALISTIC INTERPRETATION OF THE FOSSIL TAXA FROM PIRRO NORD

**Table DR3:** Correspondence between fossil nomenclature and modern species based on their modern biogeographical distribution.

| **Identified taxa as fossil** | **Corresponding modern species** | **Modern natural distribution** |
|---|---|---|
| *Pelophylax esculentus/ridibundus* | *Pelophylax* klepton *esculentus* complex | Widespread in Europe |
| *Hyla* gr. *H. arborea* | *Hyla intermedia* | Apennine Peninsula |
| *Bufotes viridis* sensu lato | *Bufotes balearicus* | Apennine Peninsula, northeastern Sicily and Tyrrhenian Islands |
| *Bufo bufo* | *Bufo bufo* | Widespread across Europe |
| *Testudo* gr. *T. hermanni* | *Testudo hermanni* | Western-central southern Europe |
| *Mauremys* sp. | *Mauremys rivulata* | Southern Balkan Peninsula and western Anatolia |
| *Emys orbicularis* | *Emys orbicularis* | Widespread across Europe |
| *Podarcis* sp. | *Podarcis sicula* | Apennine Peninsula, northern Adriatic Balkan coast, Sicily and Tyrrhenian Islands |
| | *Podarcis muralis* | Widespread across Europe |
| *Lacerta* sensu lato | *Lacerta bilineata* | Western-central Europe |
| *Natrix natrix* sensu lato | *Natrix helvetica* | Western and central-southern Europe |
| *Coronella* cf. *C. austriaca* | *Coronella austriaca* | Widespread across Europe |
| *Hierophis viridiflavus* | *Hierophis viridiflavus* | Western Europe, Apennine Peninsula and Sicily |
| *Zamenis longissimus* | *Zamenis longissimus* | Widespread across central-southern Europe |

## APPENDIX DR5: DISTRIBUTION OF THE TAXA REPRESENTED AS FOSSIL IN PIRRO NORD BY HABITATS

**Table DR4:** Habitat weighting for the Pirro Nord amphibians and reptiles.

| | open-dry | open-humid | woodland | rocky | water |
|---|---|---|---|---|---|
| *Bufotes viridis* s.l. | 0.65 | | | 0.25 | 0.1 |
| *Bufo bufo* | 0.1 | 0.3 | 0.4 | | 0.2 |
| *Pelophylax esculentus/rididundus* | | | | | 1 |
| *Pelophylax* sp. | | | | | 1 |
| *Hyla* gr. *H. arborea* | | 0.6 | 0.2 | | 0.2 |

| | | | | | |
|---|---|---|---|---|---|
| *Testudo* gr. *T. hermanni* | 0.5 | | 0.2 | 0.3 | |
| *Emys orbicularis* | | | | | 1 |
| *Mauremys* sp. | | | | | 1 |
| *Podarcis* sp. | | | | | |
| *Lacerta* s.l. | 0.5 | | 0.1 | 0.4 | |
| *Hierophis viridiflavus* | 0.4 | | 0.2 | 0.4 | |
| *Zamenis longissimus* | | 0.3 | 0.6 | | 0.1 |
| *Coronella* cf. *C. austriaca* | | 0.5 | 0.25 | 0.25 | |
| *Natrix natrix* | | 0.5 | 0.25 | | 0.25 |

## APPENDIX DR6: RECONSTRUCTED ENVIRONMENTAL PARAMETERS FOR PIRRO NORD FISSURES

**Table DR5:** Paleoenvironmental reconstruction for the different herpetofaunal assemblages from Pirro Nord according to the habitat weighting method.

| | PN1 | PN2 | PN5 | PN5b | PN9 | PN11 | PN12 | PN16 | PN17 |
|---|---|---|---|---|---|---|---|---|---|
| open-dry | 28.1% | 8.7% | 26.7% | 37.4% | 17.6% | 28.2% | 57.5% | 20.0% | 26.9% |
| open-humid | 7.1% | 0.0% | 12.2% | 1.3% | 11.2% | 13.6% | 0.0% | 14.0% | 6.2% |
| woodland | 13.1% | 2.2% | 17.2% | 10.0% | 11.8% | 17.3% | 7.5% | 15.5% | 11.9% |
| rocky | 18.5% | 6.5% | 17.8% | 28.7% | 15.0% | 18.2% | 30.0% | 15.0% | 20.8% |
| water | 33.1% | 82.6% | 26.1% | 22.6% | 44.4% | 22.7% | 5.0% | 35.5% | 34.2% |

## APPENDIX DR7: DISCUSSION ABOUT THE POSSIBLE EASTERN EMIGRANTS AMONG AMPHIBIANS AND REPTILES FROM PIRRO NORD

If *Pelobates syriacus* recorded as fossils in PN13 (Blain et al., 2016), and representing its only mention into the Apennine Peninsula, is clearly an eastern emigrant, the biogeographic links of *Mauremys*, *Blanus* and *Pseudopus* that occurred at Cava Pirro and Cava Dell'Erba (Delfino and Bailon, 2000; Delfino and Atzori, 2013) are controversial. *Mauremys* has been recorded from PN, in fissures that yielded colder temperature estimates (PN2 and PN11), and even if a dispersal from the Balkans were linked with a lower sea level —reducing the distance between the emerged continental masses of the Apennine Peninsula and the western Balkans— at the same time it is not possible to assign the PN material to species level (i.e., to the Balkan *Mauremys rivulata*). Moreover, it has to be taken into consideration that *Mauremys* inhabited the Italian Peninsula from the late Miocene to the Middle Pleistocene (Chesi et al., 2007) and therefore the Cava Pirro specimens could have a different dispersal history. Reptiles likely belonging to the genus *Blanus* (Cava Dell'Erba sites) were very common on the Italian Peninsula and its islands (among others Delfino, 1997, 2003), but rare in the Balkan fossil record (where they are now extinct; Georgalis et al., 2018). The few remains from Cava Dell'Erba (DE11) referring to the genus *Pseudopus,* could actually represent elements reworked from older levels/fissures (Delfino and Bailon, 2000; Delfino and Atzori, 2013) and cannot therefore be included in a biogeographical analysis.

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