COPEPODS FROM KUNE-VAINI LAGOONS, A TAXONOMIC AND ECOLOGICAL VIEW

Ridjola LIKA, Mihallaq QIRJO and Fundime MIRI
Department of Biology, Faculty of Natural Sciences, University of Tirana.

ABSTRACT

In this paper, we present data on copepod taxonomy and ecology of the Kune-Vaini lagoon system, as one of the main zooplankton taxa. Sampling was carried from July 2018 to July 2019, on bimonthly bases. The samples were collected in five stations, using a planktonic net (mesh size – 50 µm and mouth diameter – 25 cm) and Ruttner bottle (2 L). In each station, there were applied two sampling methodologies: a) filtering 6 liters of water using the Ruttner bottle and planktonic net for the quantitative analyses; and b) horizontal and vertical tows of the net for qualitative analyses. The biological material was preserved in formaldehyde 4%, and examinations were carried out using the Stereo microscope OLYMPUS CZX9 and Inverted Microscope OPTICA. Copepods (Arthropoda) were most represented in taxa in zooplankton (13 species). The most represented order was Harpacticioda, with *Euterpina acutifrons, Microsetella norvegica, Harpacticus gracilis, Canuella perplexa* and *Metis sp.* TheOrder Calanoida was represented by *Paracartialati setosa*, *Paracalanus parvus*, *Acartia clause* and *Acartia sp.* The Order Cyclopoida was represented by *Oithona nana*, *Oithona similis*, as well as *Ergasilus* sp. and *Cyclops* sp. Density values of copepods range from 8.8 ind./L to 1252.2 ind./L throughout the sampling months. Of the total abundance, nauplii larvae occupy more than 90% of the total number of counted individuals. The annual trend of population dynamics shows the highest peak in March for Ceka and Zaje lagoons with 283.4ind./L and 940.8 ind./L, respectively; meanwhile in Merxhani the highest density (124.8 ind./L) was observed in July 2018.
***Keywords*:** copepods, Kune-Vaini lagoons, taxonomy, abundance, population dynamics

1. INTRODUCTION

Lagoons are areas of high biological diversity and productivity (Mitsch and Gosselink, 2000). They are important for many biochemical processes, provide key ecosystem services, and are vital nursery areas (Basset and Abbiati 2004; Barnes *et al*., 2013,).

Changes within the circulation patterns of water and land fluctuations (e.g. rivers, sewage flow) make these systems extremely variable (Walsh, 1988). Dynamics of the populations may be the result of this variability. For example, the planktonic forms, which thrive in coastal systems, and can hide the underlying patterns of seasonality abundance and biomass of organisms (Calbet *et al*., 2001).

In Albania, lagoons constitute very important habitats in terms of biological diversity and other services they provide. The Kune-Vaini lagoon complex is located in the northern part of Albania and belongs to the network of protected areas of the country. It is one of the most vulnerable system in terms of climate change, impacts, and the most affected. Closure of the communication channels with the sea is one of the biggest problems facing the lagoons. It results in less communication with the sea and consequently reduced the impact of the sea on the lagoons. As a result, salinity decreases and other physical-chemical parameters change, which greatly influences the biological communities of the lagoons.

The production of copepods in any natural water body is equivalent to secondary producers, as most of them are main consumers of phytoplankton. Copepods affect phytoplankton gatherings by selectively grazing by food size (Chen *et al*., 2017, Nejstgaard *et al*., 2001; Calbet and Saiz 2005; Sherr and Sherr 2007; Calbet,2008).

Copepods are usually more numerous than other zooplankton groups, both in number and variety. They, on the other hand, contribute significantly to the food chain of many carnivores. Some fish depend mainly on the abundance of copepods, especially calanoids (Cushing, 1953; Cushing and Burd, 1957; Wimpenny, 1966; El-Rashidi, 1987).

Studies of zooplankton in Albania have been sporadic and have mainly aimed at determining species composition. This is the first study of copepods, and zooplankton, in Kune-Vaini lagoons, supported by the project *“Building the resilience of Kune-Vaini lagoons through Ecosystem-based Adaptation (EbA)”*. Besides the zooplankton, carried out by us, there were also assessed in parallel the phytoplankton, the macrophytes and the physico-chemical parameters, nutrients and photosynthetic pigments.

Knowledge of zooplankton, especially copepods helps to understand and explain the state of the food webs, and further on the state of fish stocks. Due to their small size and short life cycle, the zooplankton community is highly sensitive to environmental stresses, reflected in changes in their biomass and community. Such changes modify the links in food webs, and affect the survival of species of higher trophic levels (Richardson 2008; Taylor *et al*., 2002; etc.).

2. MATERIALS AND METHODS

The study covered the whole area of Kune-Vaini lagoon complex, located in both sides of Drini Delta in Lezha, in the north-western part of the Albanian coast. It consists of the lagoons of Merxhani and Kenalla in Kune (Northen part of Delta), and Ceka and Zaje inVaini (Southern part of Delta). The lagoon complex was formed by accumulated sediments from the Drini and Mati rivers.

Merxhani Lagoon is the most important water body, with a surface of 2.5 km^2, a mean and maximum depth of 0.75 m and 1.3 m, respectively. Communication channel of the lagoon with the sea is 500 m long, 0-70 m wide and 1-2 m deep. Ceka and Zaje Lagoons are the most important water bodies of the Vaini wetland (surface of 8.5 km^2). The mean depth is about 0.7 m with a maximum of 1.3 m. A land belt separates the two lagoons. Ceka communicates with the sea through a communication channel 1.5 km long (Miho *et al*., 2013).

Zooplankton monitoring was carried out bimonthly at five stations (Fig. 1) from July 2018 to July 2019. Three stations were in Ceka, and only one station in Zaje and Merxhani, respectively, representing relatively well each water body. Sampling was performed simultaneously, at all 5 stations at regular time intervals between the sampling periods.

Sampling was carried out using a standard plankton net (mesh size 55 µm) and Ruttner bottle (2 L). For the qualitative and quantitative assessment, two sampling modes were combined: i) Vertical and horizontal tows of the net from the boat; ii) Sampling with Ruttner bottle for quantitative assessment. In each station, a total of 6 liters of water was filtered using the planktonic net. The samples were soon fixed in 4% formaldehyde solution. Copepods were identified down to their species and genius level using an Inverted Microscope OPTICA; the counting was done using the Stereomicroscope OLYMPUS, using the literature of Trégouboff and Rose (1957), Carli and Crisafi (1983), etc.

Fig. 1. The sampling stations in Kune-Vaini lagoons, Lezha, Albania.

3. RESULTS AND DISCUSSIONS

The complete zooplankton data (list of species, abundance and plates with microscopic photos) can be found in Lika (2019). Only data on copepods, taxonomy and ecology, will be discussed in this paper, as one of the main zooplankton taxa in Kune-Vaini lagoons. Theywere represented by 3orders: calanoids, cyclopoids and harpacticoids. Calanoids are exclusively plantonic; four taxa were observed: *Paracartialati setosa*, *Paracalanus parvus*, *Acartia clausi* and *Acartia sp*. Harpacticoids, which are tychoplanktonic (Kennish, 2001), wasthe most represented order in the samples, represented by: *Euterpina acutifrons, Microsetella norvegica, Harpacticus gracilis, Canuella perplexa* and *Metis* sp. The third order of Cyclopoida was represented by *Oithona nana, O. similis,* as well as *Ergasilus*sp. and *Cyclops* sp. Ceka lagoon showed the highest diversity, with 11 species; 10 species were found in Merxhani Lagoon with and 7 species Zaje Lagoon (Tab. 1). Some microscopic photos are reported in figure 2, and their presence in each lagoon are given in Table 1.

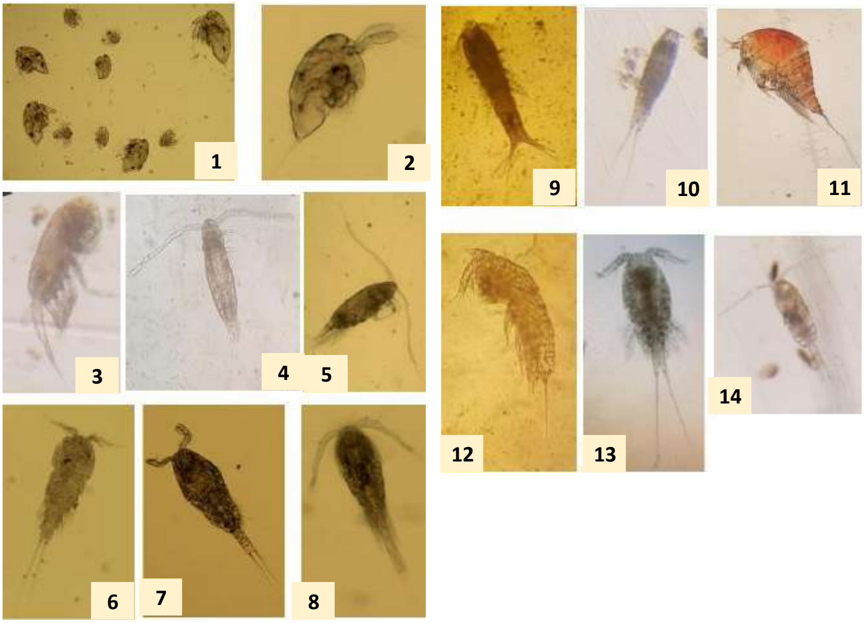

Fig. 2. Copepods from Kune-Vaini Lagoons. **1-2,** larva nauplius; **3,** *Paracalanus parvus*; **4,***Paracartialati setosa*; **5,** *Acartia* sp.; **6,** *Harpacticus gracilis*; **7,** *Ergasilus* sp.; **8,** *Oithonanana;* **9,** *Canuela perplexa*; **10,** *Microsetellanorvegica*; **11,** *Metis* sp.; **12,** *Euterpina acutifrons*; **13,** *Cyclops* sp.; **14,** *Calanoid* sp.

Tab. 1. Presence of copepod speciesin Kune-Vainlagoons (“+”present; “-“absent).

Species scientific name	**Lagoon**	**2018**			**2019**			
		Jul.	Sep.	Nov.	Jan.	Mar.	May	Jul.
Paracartialati setosa (Krichagin, 1873)	Ceka	-	-	-	-	-	-	-
	Merxhani	+	-	-	-	+	-	-
	Zaje	-	-	-	-	-	-	-
Paracalanus parvus (Claus, 1863)	Ceka	+	-	-	-	+	+	-
	Merxhani	+	+	-	-	+	-	-
	Zaje	-	-	-	-	+	-	-
Acarti aclausi (Giesbrecht, 1889)	Ceka	+	+	-	-	-	-	-
	Merxhani	+	-	-	-	+	-	-
	Zaje	-	-	-	-	+	-	-
Acartia sp.	Ceka	-	-	-	-	+	-	+
	Merxhani	-	-	-	-	+	-	+
	Zaje	-	-	-	-	+	-	-
Oithona nana (Giesbrecht, 1893),	Ceka	+	+	+	+	-	-	-
	Merxhani	+	-	-	+	+	-	+
	Zaje	-	-	-	-	-	-	-

Species scientific name	**Lagoon**	**2018**			**2019**			
		Jul.	Sep.	Nov.	Jan.	Mar.	May	Jul.
Oithona similis (Claus, 1866)	Ceka	-	+	-	-	-	-	-
	Merxhani	-	-	-	+	-	-	-
	Zaje	-	-	-	-	-	-	-
Ergasilus sp.	Ceka	-	-	+	-	-	-	-
	Merxhani	+	-	-	-	-	-	-
	Zaje	-	-	-	-	-	-	-
Cyclops sp.	Ceka	+	-	-	-	-	-	+
	Merxhani	-	-	-	-	-	-	-
	Zaje	-	-	-	-	-	-	-
Euterpina acutifrons (Dana, 1847)	Ceka	+	+	+	+	+	-	+
	Merxhani	+	+	-	+	+	+	-
	Zaje	-	-	-	-	-	-	-
Microsetella norvegica (Boeck, 1865)	Ceka	+	-	-	-	-	-	+
	Merxhani	-	-	-	-	+	-	-
	Zaje	+	-	-	-	-	-	-
Harpacticus gracilis (Claus, 1863)	Ceka	-	-	-	-	-	-	+
	Merxhani	-	-	-	-	+	+	+
	Zaje	-	-	-	-	+	-	-
Metis sp.	Ceka	-	-	-	-	-	-	-
	Merxhani	-	-	-	-	-	-	-
	Zaje	-	-	-	-	-	+	-
Canuella perplexa (Scott T. & Scott A., 1893)	Ceka	+	+	-	-	+	-	+
	Merxhani	+	-	-	-	+	-	-
	Zaje	+	-	+	+	-	+	+
Nauplii	Ceka	+	+	+	+	+	+	+
	Merxhani	+	+	+	+	+	+	+
	Zaje	+	+	+	+	+	+	+

Ca. 17,391 individuals were counted during all sampling period in all the stations; 16,657 individuals belonged to nauplii larvae (96%). They were present in samples throughout the sampling period at all stations (Tab. 1). The harpacticoids *M. norvegica* and *H. gracilis* showed the highest abundance, respectively 237 and 193 individuals, followed by *P. parvus* with 69 individuals (Fig.3).

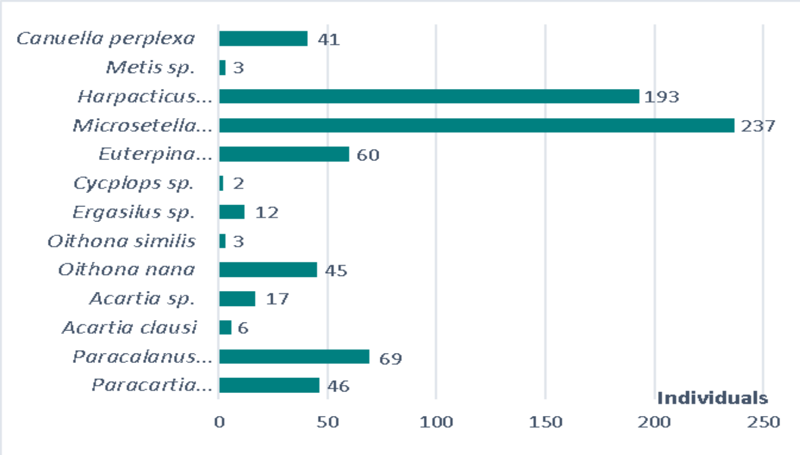

Fig. 3. Average abundance of copepod taxa in Kune-Vain lagoons.

The annual trend of copepods in the three lagoons is reported in Fig. 4, nauplii larvae, are the main drivers of the overall performance. In the Ceka Lagoon, the highest density was in spring, March 2019 (283.4 ind./L); the peak of larval density was up to 278.6 ind./L. In the Merxhani Lagoon, the highest peaks were in July 2018 (124.5 ind./L) and January 2019 (85.2 ind./L); the same pattern was observed for the density of nauplii larvae, respectively 122.5 ind./L in July 2018 and 83.8 ind./L in January 2019. In the Zaje Lagoon, were observed two peaks, respectively in spring (March 2019) and a smaller one in autumn (September 2018), respectively 940.8 ind./L and 138 ind./L. Nauplii larvae seemed to be determinant, reaching the highest density in March 2019 and September 2018, respectively 916.7 ind./L and 138 ind./L.

The copepods dynamics during all sampling months, in the three lagoons, were compared with the values of some chemical parameters presented by Muçaj (2019), shown in the Tab. 2. This study was performed at the same time, same stations and same frequency as the study of zooplankton (copepods).

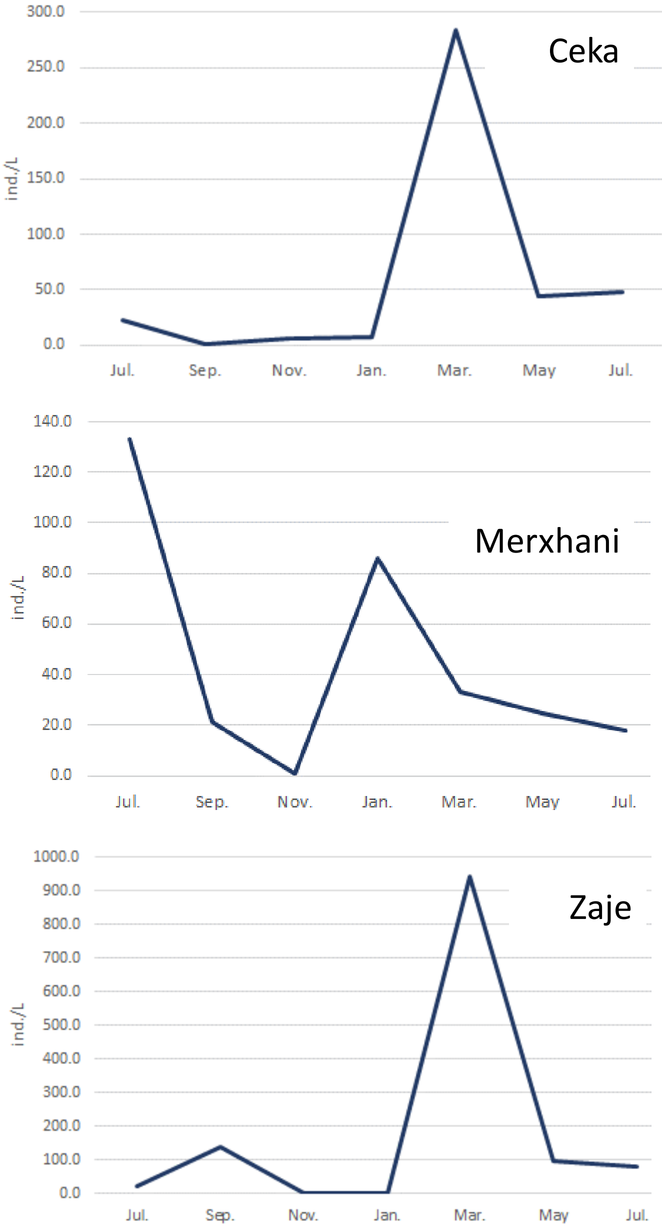

Fig. 4. The annual trend of copepods in the three Lezha lagoons.

Tab. 2. Temperature, salinity and copepod density data at the three Lezha lagoons (data from Muçaj, 2019).

Month	Lagoons	Temperature (° C)	Salinity (‰)	Copepods density (ind./L)
July 2018	Ceka	28.5		22.9
	Merxhani	28.1		133.3
	Zaje	28		22.2
September 2018	Ceka	27.1	23.9	1.7
	Merxhani	26.2	40.2	21.3
	Zaje	24.2	14.2	138.0
November 2018	Ceka	13.3	34.2	6.4
	Merxhani	11.4	41	1.2
	Zaje	13	18.4	1.2
January 2019	Ceka	1.0	19.5	6.9
	Merxhani	4.0	25.2	86.2
	Zaje	3.0	13.3	1.8
March 2019	Ceka	16.0	17,9	238.4
	Merxhani	15.8	36.8	33.0
	Zaje	15.8	16.1	940.8
May 2019	Ceka	23.1	17.5	43.6
	Merxhani	24.6	30.4	24.5
	Zaje	24.2	8	83.0
July 2019	Ceka	26.4	26.2	47.4
	Merxhani	25.7	37.4	17.7
	Zaje	25.8	13	83.0

Based on water temperature, the copepods density decreased with temperature;1, 4 and 3°C in January 2019, respectively for Ceka, Merxhani and Zaje lagoons. But, copepods density increases when salinity gets lower values. In Ceka, at a salinity level of 17.8‰ the copepods density reaches the highest peak – 283.4 ind./L (see Fig. 4); in Merxhani, the lowest salinity is met in January (25.2‰), where we have one of the highest values of copepod density (85.2 ind./L). The same was seen in the Zaja Lagoon, where at the lowest salinity (10‰) in March, we have the highest level of density of copepods (940.8 ind./L).

4. CONCLUSIONS

Copepods in the Kune-Vaini Lagoon Complex were presented by 13 species; 9 were determined at the species level and 4 up to the genus level. Ceka showed the highest diversity, with 11 species; Merxhani with 10 species and Zaje with only 7 species. *M. norvegica* was the most abundant species with 237 individuals counted, followed by *H. gracilis* with 193 individuals and *P. parvus* with 69 individuals.

Copepods in Ceka lagoon showed the highest density in the spring, March 2019 (283.4 ind./L). In the Merxhani lagoon, the highest peaks were reached in July 2018 (124.5 ind./L) and January 2019 (85.2 ind./L). In the Zaje lagoon, copepods reached two peaks, respectively in spring (March 2019) and a smaller one in autumn (September 2018), respectively 940.8 ind./L and 138 ind./L. Nauplii larvae occupied 96% of the total number of copepods counted. They were the main drivers of the overall performance of copepods in the three lagoons.

ACKNOWLEDGMENTS

The study was part of the Master Program focused on the ecological approach of the wetland complex, financially supported by the Kune-Vaini Project (http://kunevain.com).

REFERENCES:

Basset A, Abbiati M. 2004. Challenges to transitional water monitoring: ecological descriptors and scales. Aquatic conservation: marine and freshwater ecosystems 14: s1-s3.

Calbet A. 2008. The trophic roles of microzooplankton in marine systems. *ICES J. Mar. Sci*., 65: 325–331.

Calbet A, Garrido S, Saiz E, Alcaraz M, Duarte CM. 2001. Annual zooplankton succession in coastal NW Mediterranean waters: the importance of the smaller size fractions. *J. Plankton Res.* **23:** 319–331.

Carli A, Crisafi P. 1983. Copepodi lagunari. In: Guide per il riconoscimento delle specie animali delle acque lagunari e costiere italiane. 11. AQ/1/230, CNR, Roma. 125 pp.

Chen M, Liu H, Chen B.2017. Seasonal variability of mesozooplankton feeding rates on phytoplankton in subtropical coastal and estuarine waters. *Front. Mar. Sci.*, 4:186 pp.

Cushing DH. 1953. Studies on plankton populations. J. Cons., Int. Explor. Mer., 19(1): 2–22.

Cushing DH, Burd AC. 1957. On the herring of the southern North Sea. *Fish. Invert., Lon. Ser*. 2, **20(11):** 1–31.

Johnson WS, Allen DM.2012. Zooplankton of the Atlantic and Gulf coasts: A guide to their identification and ecology,2nded. JHU Press.

Kennish MJ. 2000. Practical handbook of marine science. Third edition. Crs marine science series: 896 pp.

Lika R. 2019. Zooplankton dynamics in Kune-Vaini Lagoon system Lezha. Master theses, FNS, UT. 81 pp.

Miho A, Kashta L, Beqiraj S. 2013. Between the Land and the Sea - Ecoguide to discover the transitional waters of Albania. Julvin 2, Tiranë. 462 pphttp://www.fshn.edu.al/home/publikime-shkencore.

Mitsch WJ, Gosselink JG. 2000. The Value of Wetlands: Importance of Scale and Landscape Setting. Ecological Economics, 35: 25-33. http://dx.doi.org/10.1016/S0921-8009(00)00165-8

Muçaj D. 2019. Karakteristikat fiziko-kimike dhe vlerësimi i cilësisë së ujërave të kompleksit lagunor të Kune-Vainit. Mikrotezë, FShN, UT. 67 pp.

Nejstgaard JC, Naustvoll L, Sazhin A. 2001. Correcting for underestimation of microzooplanton grazing in bottle incubation experiments with mesozooplankton. *Mar. Ecol. Prog. Ser*., 221:59–75.

Rashidi HH. 1987. Ictyhyoplankton of the south eastern Mediterranean Sea of the Egyptian Coast (M.Sc. thesis). Fac. Sci. Alexandria University, Egypt.

Richardson AJ. 2008. In hot water: zooplankton and climate change, *ICES Journal of Marine Science*, **65/3:** 279–295.

Rollwagen Bollens GC, Penry DL. 2003. Feeding dynamics of *Acartia* spp. copepods in a large, temperate estuary (San Francisco Bay, CA). *Mar. Ecol. Prog. Ser*., 257:139–158.

Rose M. 1933. Copépodes Pélagiques. Series, Faune de France. Type, Book/Report. Source, Faune de France, Faune, 26. 374 pp,

Sherr EB, Sherr BF. 2007. Heterotrophic dinoflagellates: A significant component of microzooplankton biomass and major grazers of diatoms in the sea. *Mar. Ecol. Prog. Ser*., **352:**187–197.

Taylor AH, Allen JI, Clark PA. 2002. Extraction of a weak climatic signal by an ecosystem. Nature, **416:** 629-632.

Trégouboff G, Maurice Rose M. (1957).*Manuel de Planktonologie Méditerranéenne.*Paris: Centre National de la Recheche Scientifique.

Walsh JJ. 1988. On the Nature of Continental Shelves. Academic Press, London. 520 pp.

Wimpenny RS. 1966. The Plankton of the Sea. Faber and Faber, London. 426 pp.