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ICHTHYOFAUNA OF THE GIANH RIVER BASIN FROM VIETNAM

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Abstract of the doctoral thesis in Biological Sciences

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CONCEPTUAL GUIDE MARK OF RESEARCH

Actuality of topic. Nowadays the solving of biodiversity problems has a great importance in the conditions of a rise of anthropic influence at local, regional, and world level. The study of the fish resources in the basin of river Gianh is justified both by the insufficient study of this unique macroecosystem from the point of view of specific and hydrobiotopic diversity and the necessity of elaboration of adequate environmental policies with the purpose of protection and sustainable valorification of fish resources which can be achieved only through a deep knowledge of the structural-functional ichthyochenoses from the region and their determining factors. There are especially proposed scientific-practical recommendations for protection of ichthyofauna of the National Park Nha - Ke Bang.

Description of situation in the research domain. The remarkable thing about the study of fish in the Gianh river basin, in recent years Nguyen Thai Tu and colleagues 1999 published 72 species of fish distributing in the Phong Nha - Ke Bang, but in which 13 species were not identified. By the years 1998 - 2001, the scientist team of the Institute of Ecology and Biological Resources of Vietnam Academy of Science and Technology studied in the Phong Nha - Ke Bang National Park and announced 75 species of fish distributed here including 8 species were not identified [15]. In 2002 - 2003, Ngo Sy Van et al. published 121 fish species distributed in the Phong Nha - Ke Bang National Park, in which there were 23 species still unidentified [15]. At the same period, Nguyen Thai Tu published 162 species and 58 unidentifiable species in this area [22]. In the mainstream of Gianh River, Mai Thị Thanh Phuong et al. recorded 123 fish species and 6 unidentifiable species [10]. However, this study still remains some problems in terms of classification. For examples, fish genus *Schistura* consisted 8 species in the Gianh river basin but 1 species not yet identified. Meanwhile, Freyhof & Dmitri V. Serov reported that genus *Schistura* the Gianh river basin includes 2 species: *Schistura hingi* and *Schistura pervagata*. Comparing the obtained results by Mai Thi Thanh Phuong and al., it is obvious that the study of fish species in the basin of river Gianh faces difficulties concerning the taxonomic positioning at genus and species level. The results of these studies demonstrate that now the principles of classification of fish species in the basin of river Gianh in particular and of fish fauna of Vietnam in general are not unanimously approved by all researchers and do not follow entirely the demands of the International Code of Zoological Nomenclature (2001), raising many questions about the veracity of the number of attested taxonomic units of different rank. [1].

The important scientific problem solved in the thesis consists in the actualization of ichthyofauna diversity and the peculiarities of distribution of fish species in the basin of river Gianh which led to the elaboration of scientific-practical recommendations for the conservation and rational use of fisheries.

Research purpose. Evaluation of the ichthyofaunistic diversity in the basin of river Gianh, and elaboration of recommendations for protection and durable use of fish resources.

Objectives of the research:

- Inventory and reactualization of ichthyofaunistic diversity of the basin of river Gianh from Vietnam.
- Comparative analysis of morphometric and meristic characters of identified species.
- Systematization of fish species according to types of populated aquatic ecosystems and habitats from National Park Phong Nha - Ke Bang.

- Study of peculiarities of spatial and temporal distribution of fish species from the basin of river Gianh.
- Identification of fish species with high economic value and of the allogenic ones from the basin of river Gianh.
- Survey of fish species with different status of rarity from the basin of river Gianh which are included in the Red Book of Vietnam and International Red List (IUCN).
- Evaluation of the state of fish species populations from the basin of river Gianh, and of the ecological factors with important influence upon their functioning.
- Elaboration of scientific recommendations for a sustainable valorification and adequate protection of fish resources.

Methodology of scientific research: Works of Chen Yiyu et al. (1998); Chu Xinluo et al. (1999); Do Thi Nhu Nhung (2007); Freyhof J., F. Herder (2002); Hartel K. E., T. Nakabo (2003); Knapp L. W (1999); Kottelat M (1990); Kottelat M., Freyhof J. (2007); Mai Dinh Yen (1978); Mai Dinh Yen et al. (1992); Menon A. (1977); Nakabo T (1982, 1983); Nguyen Huu Phung (2001); Nguyen Khac Huong (1991, 2001; 2007); Nguyen Nhat Thi (1991, 2001); Nguyen Van Hao, Ngo Si Van (2001); Nguyen Van Hao (2005); Nguyen Van Luc et al. (2007); Ochiai A. et al. (1955); Prokofiev A. M. (2010); Rainboth J. (1996); Tetsji Nakabo (2002); William P. (1966); Yokogawa K. et al. (2008); Yue Peiqi et al (2000).... Statistical and correlational calculation was performed using MS Excel software.

Novelty and scientific originality. For the first time there has been composed a complete list of fish species from the basin of river Gianh and there have been described the morphological characters of identified taxons. There have been analyzed peculiarities of spatial distribution of the fish species in the basin of river Gianh. The species have been systematized according to their economic value, origin, and national and international status of rarity. There have been identified 3 new species for research: *Schistura kottelati* Tuan et al., 2015; *Carassioides phongnhaensis* Tu & Tuan, 2003 and *Cyprinus hieni* Tu & Tuan, 2003.

Theoretical importance. The scientific information about the diversity of ichthyofauna in the basin of river Gianh and the National Park Phong Nha - Ke Bang was updated. There were identified and described 3 new fish species for science. There were analyzed the metric and meristic characters of the caught species. The information about the fish species has been systematized according to peculiarities of spatial distribution, economic value, and origin and rarity status designated by national and international Red List (IUCN).

Applicative value of work. The obtained results served as scientific basis for developing recommendations for the protection and sustainable use of fish resources in the basin of river Gianh**.**

The main scientific results submitted to support.

1. The diversity of ichthyofauna is in a positive correlation with the diversity of hydrobiotopes and environment gradients established in the ecosystem. There have been identified 181 fish species that belong to 139 genera, 64 families and 16 orders in the hydrographic of Gianh river basin. There have been identified 119 species in the Phong Nha - Ke Bang National Park: 21 species in cave ecosystems, 20 species in rice fields (and other flooding zones), 52 species in ponds and dam lakes, 72 species in upstream, 66 species in middle, 69 species in downstream, and 109 species in estuary zone.

2. The ichthyofauna of river Gianh is unique as to its number of species, share of stenotopic species, and an impressive number of rare species which are important for community and those which were insufficiently studied (DD and NE according to IUCN).
3. In order to efficiently protect a species and to insure the success of its perpetuation in time and space an integral protection of its habitat is necessary.
4. In present ecological conditions it is impossible to omit totally the anthropic factor on fish resources in the region (as a result of continually industrialization, demographics, etc.), but it is possible to find an optimal formula for a less hostile coexistence, and why not, a friendly one.

Implementation of the results. The obtained results on the topic of the thesis were implemented in specialized institutions of Vietnam: Society of Hunters and Fishermen, Forestry Protection Department, Department of Science and Technology, and also in the teaching process at University Vinh from Vietnam and Moldova State University.

Approvement of scientific results. The results of the thesis were presented in multiple events and scientific meetings: The problems of basic research in life sciences at the University of Hue in 2003; A number of scientific studies in Biology at the University of Vinh in 2006; The global scientific values of Phong Nha - Ke Bang National Park in Dong Hoi, Quang Binh Province in 2008; The 4th National conference on Ecology and Biological resources in 2009; The 6th National conference on Ecology and Biological resources in 2013; Report on the results of the investigation of biodiversity in Phong Nha - Ke Bang National Park in Dong Hoi, Quang Binh Province in 2012; Report on Biodiversity of freshwater fish in Quang Binh Province by Department of Science and Technology Quang Binh Province in 2012; The 6th National conference on Ecology and Biological resources in 2013.

Publications. The obtained results have been published in 15 scientific works, including: articles in international scientific journals: 2 (an article (Scopus) publishing); Articles in national scientific journals: 5 (2 articles with mono-author publishing); Participation in international conference: 5; Participation in project realization: 3 (2 projects with status project leader).

Thesis structure: The thesis consists of 4 chapters, conclusions and recommendations, has a base volume of 150 pages with 326 cited literature, 20 figures, 7 tables, 3 annexes (21 pages, 193 figures).

Keywords: Vietnam ichthyofauna, taxonomic status, meristic character, metric character, invasive species, economically valuable species, sustainable valorification.

CONTENTS OF THESIS

INTRODUCTION. The Gianh river basin locates in Quang Binh Province in Vietnam's North Central Coast. North Central region ranges from Thua Thien Hue province in the south to Thanh Hoa province in the north. The terrain is divided into three regions: the plain, midland and mountainous areas. The Gianh river is 158 km long and the basin area approximately 4680 km^2.

1. History of studies of fish in Vietnam.

Vietnam passed under aggression wars by the Japanese, the French and American imperialist. Hence, the sciences had the late starting. Like other sciences, ichthyology in Vietnam began from the second half of the eighteenth century, along with the penetration of Western scientists. According to Mai Dinh Yen may divide the development of Vietnamese Fisheries into 3 periods.

Feudal Period (period before 1881). This period was mainly sporadic knowledge of fish life, breeding, fishery and fish processing were recorded in the history and economists feudal.

French colonial period (1881 - 1954). This period is mainly the French fishermen and some kind of scientists from UK, USA, China. The ichthyology researches were mainly done by the foreign ichthyologists, without the ichthyologists of Vietnam, they studied a lot of morphological classification and fish fauna of the country. Although that was not much and sufficient, it was the foundation to provide Vietnamese ichthyologists documents, methods and approaches to further study.

Third period from 1954 to present. The period can be divided into two stages from 1954 -1975 and from 1975 to present. ***Period from 1954 to 1975*.** In this period, the country was under US occupation in the south. Therefore in these years It mainly had staff training and initial construction of infrastructure in the North, in preparation for the construction of the country latter. So this time only a few studies of small nature were done in some places in North. In this phase, the research was primarily conducted by researchers of the Institute of Aquaculture Research I and Hanoi synthetic university. ***Period from 1975 to present*.** This period in Vietnam had ichthyologists as: Nguyen Nhat Thi, Bui Dinh Chung, Le Trong Phan, Nguyen Khac Huong, Nguyen Huu Phung, Pham Thuoc, Chu Tien Vinh... studies of marine fish. Mai Dinh Yen, Vu Trung Tang, Nguyen Thai Tu, Nguyen Huu Duc, Vo Van Phu, Nguyen Van Hao, Hoang Duc Dat, Nguyen Xuan Huan ... studied freshwater fish. It can be said that this period, Vietnamese ichthyology actually achieved certain results, including the quantity and quality. Besides it also trained many researchers such as: Nguyen Thi Thu He (2000); Duong Quang Ngoc (2008); Nguyen Thi Phi Loan, Vu Thi Phuong Anh, Nguyen Minh Ty (2010); Nguyen Xuan Khoa, Nguyen Thi Hoa, Tong Xuan Tam (2011); Ta Thi Thuy (2012).

2. MATERIAL AND METHODS

2.1. Metode de colectare şi prelucrare a probelor. In the paper there are shown the results of the investigation of ichthyofauna in the basin of river Gianh which were obtained during the research period 2003-2015.

There have been performed 12 surveys in the field during the years 2003 - 2011 in 36 places of collection. There were analysed 1882 specimens from metric and meristic point of view.

Fish collection was performed with various selective and non-selective gears as: nets, fishing nets, fishing rods, and some traditional fishing gear of the local people. Some of the fish were bought from the local people.

Specimens were systematized in logs, photographed and fixed by formaldehyde 8 - 10% then were preserved in formaldehyde solution 5% and stored in Laboratory of Animals, Department of Biology, Vinh University

2.2. Determination method. We use the following materials to Identification species: Chen Yiyu et al. (1998); Chu Xinluo et al. (1999); Do Thi Nhu Nhung (2007); Freyhof J., F. Herder (2002); Hartel K. E., T. Nakabo (2003); Knapp L. W (1999); Kottelat M (1990); Kottelat M., Freyhof J. (2007); Mai Dinh Yen (1978); Mai Dinh Yen et al. (1992); Menon A. (1977); Nakabo T (1982, 1983); Nguyen Huu Phung (2001); Nguyen Khac Huong (1991, 2001; 2007); Nguyen Nhat Thi (1991, 2001); Nguyen Van Hao, Ngo Si Van (2001); Nguyen Van Hao (2005); Nguyen Van Luc et al. (2007); Ochiai A. et al. (1955); Prokofiev A. M. (2010); Rainboth J. (1996); Tetsji Nakabo (2002); William P. (1966); Yokogawa K. et al. (2008); Yue Peiqi et al (2000).

3. THE TAXONOMIC DIVERSITY AND ECOLOGICAL PECULIARITIES OF FISH SPECIES IN GIANH RIVER BASIN

3.1. Fish biodiversity in Gianh river basin

It is important to be mentioned that the rich fish diversity of Vietnam represents the result of the complex action of ecological, geographical, and climatic factors (relatively constant temperature, long and abundant rains, systematic floodings on big areas, the diversity of relief with numerous types of natural ecosystems, variations of altitude, tangent with the sea area, etc.) conditioned the appearance of many ecological niches which are occupied by stenobiont species (cave species with low visual sense; oxyresistent species characteristic to flooded areas with highly developed sense of touch and specific modes of locomotion, respiration and reproduction; oxiphile and cryophilic high altitude species; stenohaline marine species, etc.).

During the performed study in the basin of river Gianh from Quang Binh (north-central Vietnam) there have been determined 181 fish species which belong to 139 genera, 64 families and 16 orders. There have been identified **3 new species for science**: *Schistura kottelati* Tuan et al., 2015; *Carassioides phongnhaensis* Tu & Tuan, 2003 and *Cyprinus hieni* Tu & Tuan, 2003 (Figure. 1, 2, 3).

Fig. 1. *Carassioides phongnhaensis*

Fig. 2. *Cyprinus hieni*

Fig. 3. *Schistura kottelati*

In determining some problem species there have been involved international specialists such as M. Kottelat and J. Freyhof. 2 taxons from the family Cyprinidae are still in the course of checking and confirming affiliation to species. (Table 3.1.)

3.1. Composition of fish species in Gianh river basin

Table 3.1. Composition of fish species in Gianh river basin

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
N^0	**Scientific name**	**RB**	**IUCN**	**EV**	**IS**	**Distribution**							
						PN - KB National Park		**Water bodies**					
								Standing water		**Running water**			
A	**CLASS CHONDRICHTHYES**												
I.	**ORDER RAJIFORMES**												
(1).	**FAMILY RAJIDAE**												
1.	*Dasyatis sinensis* (Steindachner, 1892)		**DD**										+
II.	**ORDER MYLIOBATIFORMES**												
(2).	**FAMILY GYMNURIDAE**												
2.	*Gymnura poecilura* (Shaw, 1804)		**NT**										+
B	**CLASS ACTINOPTERYGII**												
III.	**ORDER OSTEOGLOSSIFORMES**												
(3).	**FAMILY NOTOPTERIDAE**												
3.	*Notopterus notopterus* (Pallas, 1769)		**LC**	*		+			+		+	+	+
IV.	**ORDER ANGUILLIFORMES**												
(4).	**FAMILY ANGUILLIDAE**												
4.	*Anguilla marmorata* Quoy & Gaimard, 1824	**VU**	**LC**	*		+	+		+	+	+	+	+
(5).	**FAMILY OPHICHTHIDAE**												
5.	*Ophichthus celebicus* (Bleeker, 1856) Add		**NE**										+
6.	*Pisodonophis boro* (Hamilton, 1822) Add		**LC**										+
(6).	**FAMILY CONGRIDAE**												
7.	*Gnathophis nystromi* (Jordan & Snyder, 1901) Add		**NE**										+
8.	*Rhynchoconger ectenurus* (Jor. & Ric., 1909) Add		**NE**										+
V.	**ORDER CLUPEIFORMES**												
(7).	**FAMILY CLUPEIDAE**												
9.	*Clupanodon thrissa* (Linnaeus, 1758)	**EN**	**NE**	*		+						+	+
10.	*Konosirus punctatus* (Tem. & Sch., 1846)	**VU**	**NE**	*		+						+	+

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
11.	*Escualosa thoracata* (Valenciennes, 1847) Add		**NE**										+
12.	*Sardinella albella* (Valenciennes, 1847) Add		**LC**	*									+
(8).	**FAMILY ENGRAULIDAE**												
13.	*Thryssa vitrirostris* (Gil. & Tho., 1908) Add		**NE**										+
VI.	**ORDER CYPRINIFORMES**												
(9).	**FAMILY CYPRINIDAE**												
14.	*Acheilognathus lamus* Tu, 1983		**NE**			+				+	+		
15.	*Acheilognathus tonkinensis* (Vailant, 1892)		**DD**			+	+			+	+		
16.	*Rhodeus kyphus* (Yen, 1978)		**NE**			+				+			
17.	*Rhodeus ocellatus* (Kener, 1867)		**DD**			+	+			+			
18.	*Rhodeus spinalis* Oshima, 1926		**LC**			+				+			
19.	*Cultrichthys erythropterus* (Basilewsky, 1855)		**LC**						+		+		
20.	*Hemiculter leucisculus* (Basilewsky, 1855)		**LC**	*****		+		+	+	+	+	+	
21.	*Pseudohemiculter dispar* (Peters, 1881)		**VU**						+		+		
22.	*Carassioides acuminatus* (Richardson, 1846)		**LC**	*****		+			+	+	+	+	
23.	*Carassioides phongnhaensis* Tu & Tuan, 2003		**DD**			+					+		
24.	*Carassius auratus* (Linnaeus, 1785)		**LC**	*****		+		+	+	+	+	+	+
25.	*Cyprinus carpio* Linnaeus, 1758		**VU**	*****	+	+		+	+	+	+	+	+
26.	*Cyprinus hieni* Tu & Tuan, 2003		**DD**			+			+	+	+		
27.	*Cyprinus quidatensis* Tu, 1999		**DD**			+				+			
28.	*Puntius brevis* (Bleeker, 1849)		**LC**			+		+	+	+	+	+	+
29.	*Puntius semifasciolatus* (Günther, 1868)		**LC**			+		+	+	+	+	+	+
30.	*Cirrhinus molitorella* (Valenciennes, 1844)		**NT**	*****		+		+	+	+	+	+	+
31.	*Garra imberba* Garman, 1912		**DD**	*****		+	+			+			
32.	*Osteochilus lini* Fowler, 1935		**LC**			+			+	+	+	+	
33.	*Osteochilus salsburyi* Nichols & Pope, 1927		**LC**	*****		+			+	+	+	+	
34.	*Ctenopharyngodon idella* (Val., 1844)		**NE**	*****	+	+		+	+	+	+	+	
35.	*Squaliobarbus curriculus* (Richardson, 1846)		**DD**	*****		+			+		+	+	
36.	*Hypophthalmichthys molitrix* (Valenciennes, 1844)		**NT**	*****	+	**+**			+	+	+	+	
37.	*Hemibarbus umbrifer* (Lin, 1931)		**LC**	*****		+			+	+	+	+	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
38.	*Microphysogobio kachekensis* (Oshima, 1926)		**LC**	*		+				+	+	+	
39.	*Sarcocheilichthys parvus* Nichols, 1930		**LC**			+				+	+		
40.	*Squalidus argentatus* (Sau. & Dab. Thi., 1874)		**DD**			+			+	+	+	+	
41.	*Devario fangfangae* (Kottelat, 2000) Add		**LC**			+				+			
42.	*Devario gibber* (Kottelat, 2000) Add		**LC**			+				+			
43.	*Esomus metallicus* Ahl, 1923 Add		**LC**			+		+	+	+	+		
44.	*Esomus longimanus* (Lunel, 1881) Add		**DD**			+		+	+		+	+	
45.	*Rasbora steineri* Nichols & Pope, 1927		**LC**			+	+		+	+	+		
46.	*Hypsibarbus annamensis* (Pel. & Che., 1936)	**VU**	**DD**	*		+				+			
47.	*Hypsibarbus macrosquamatus* (Mai, 1978)		**DD**	*		+				+			
48.	*Nicholsicypris dorsohorizontalis* Ng. & Do., 1969		**NE**	*		+	+			+	+		
49.	*Neolissochilus benasi* (Pellegrin & Chevey, 1936)		**DD**	*		+	+			+			
50.	*Onychostoma gerlachi* (Peters, 1881)		**NT**	*		+				+	+		
51.	*Opsariichthys bidens* Günther, 1873		**LC**	*		+	+			+	+		
52.	*Paraspinibarbus macracanthus* (Pel. & Che., 1936)		**DD**	*		+			+	+	+		
53.	*Poropuntius solitus* Kottelat, 2000 Add		**EN**	*		+	+			+			
54.	*Spinibarbus denticulatus* (Oshima, 1926)		**LC**	*		+	+		+	+			
55.	*Spinibarbus hollandi* Oshima, 1919		**DD**	*		+			+	+	+		
56.	*Metzia lineata* (Pellegrin, 1907)		**LC**			+			+		+		
(10).	**FAMILY COBITIDAE**												
57.	*Cobitis laoensis* (Sauvage, 1878)		**LC**	*		+	+	+	+	+	+		
58.	*Misgurnus anguillicaulatus* (Cantor, 1842)		**NE**	*		+	+	+	+		+	+	
59.	*Misgurnus mizolepis* Günther, 1888		**NE**	*		+	+	+	+	+			
(11).	**FAMILY BALITORIDAE**												
60.	*Annamia normani* (Hora, 1931)		**LC**			+				+			
61.	*Sewellia lineolata* (Valenciennes, 1836)		**VU**			+				+			
(12).	**FAMILY NEMACHEILIDAE**												
62.	*Schistura finis* Kottelat, 2000 Add		**DD**			+				+			
63.	*Schistura hingi* (Herre, 1934)		**LC**	*		+				+			
64.	*Schistura pervagata* Kottelat, 1998		**LC**	*		+				+			

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
65.	*Schistura kottelati* Tuan et all Add		**NE**			+				+			
66.	*Traccatichthys taeniatus* (Pel. & Che., 1936)		**NE**	*		+			+	+	+		
VII.	**ORDER SILURIFORMES**												
(13).	**FAMILY BAGRIDAE**												
67.	*Mystus gulio* (Hamilton, 1822)		**LC**			+			+	+	+		
68.	*Hemibagrus centralus* Mai, 1978		**DD**	*		+			+	+	+		
69.	*Tachysurus virgatus* (Oshima, 1926)		**DD**	*		+			+	+	+		
(14).	**FAMILY SILURIDAE**												
70.	*Silurus asotus* Linnaeus, 1758		**LC**	*		+	+			+	+		
71.	*Pterocryptis cochinchinensis* (Val., 1840)		**LC**	*		+	+		+	+	+		
(15).	**FAMILY SISORIDAE**												
72.	*Glyptothorax laosensis* Fowler, 1934 Add		**LC**			+			+	+	+		
73.	*Glyptothorax interspinalus* (Mai, 1978) Add		**NT**			+				+	+		
74.	*Glyptothorax quadriocellatus* (Mai, 1978)		**DD**			+				+	+		
75.	*Glyptothorax zanaensis* Wu, He & Chu, 1981 Add		**NE**			+	+			+	+		
(16).	**FAMILY CLARIIDAE**												
76.	*Clarias fuscus* (Linnaeus, 1758)		**LC**	*		+		+	+		+	+	
(17).	**FAMILY PLOTOSIDAE**												
77.	*Plotosus lineatus* (Thunberg năm 1787)		**NE**	*								+	+
VIII.	**ORDER AULOPIFORMES**												
(18).	**FAMILY SYNODONTIDAE**												
78.	*Saurida elongata* (Tem. & Sch., 1846)		**NE**	*		+							+
IX.	**ORDER ATHERINIFORMES**												
(19).	**FAMILY ATHERINIDAE**												
79.	*Hypoatherina valenciennei* (Bleeker, 1854) Add		**NE**										+
X.	**ORDER BELONIFORMES**												
(20).	**FAMILY BELONIDAE**												
80.	*Strongylura strongylura* (van Hasselt, 1823)		**NE**	*								+	+
(21).	**FAMILY HEMIRAMPHIDAE**												
81.	*Hyporhamphus sinensis* (Günther 1866)		**LC**			+						+	+

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
XI.	**ORDER SYNGNATHIFORMES**												
(22).	**FAMILY SYNGNATHIDAE**												
82.	*Microphis cuncalus* (Hamilton, 1822) Add		**LC**									+	+
83.	*Hippichthys spicifer* (Rüppell, 1838) Add		**LC**									+	+
XII.	**ORDER SYNBRANCHIFORMES**												
(23).	**FAMILY SYNBRANCHIDAE**												
84.	*Monopterus albus* (Zuiew, 1793)		**LC**	*****		+	+	+	+	+	+	+	
(24).	**FAMILY MASTACEMBELIDAE**												
85.	*Mastacembelus armatus* (Lacepède, 1800)		**LC**	*****		+	+		+	+	+	+	
86.	*Sinobdella sinensis* (Bleeker, 1870)		**LC**	*****		+	+		+	+	+	+	
XIII.	**ORDER SCORPAENIFORMES**												
(25).	**FAMILY TETRAROGIDAE**												
87.	*Paracentropogon rubripinnis* (Tem. & Sch., 1843)		**NE**										+
(26).	**FAMILY SYNANCEIIDAE**												
88.	*Minous pusillus* (Tem. & Sch., 1843) Add		**NE**										+
(27).	**FAMILY PLATYCEPHALIDAE**												
89.	*Platycephalus indicus* (Linnaeus, 1758)		**DD**	*****		+						+	+
90.	*Rogadius serratus* (Cuvier, 1829) Add		**NE**	*****									+
91.	*Sorsogona tuberculata* (Cuvier, 1829) Add		**NE**	*****									+
XIV.	**ORDER PERCIFORMES**												
(28).	**FAMILY AMBASSIDAE**												
92.	*Ambassis ambassis* (Lacepède, 1802)		**LC**			+				+	+	+	
(29).	**FAMILY PERCICHTHYIDAE**												
93.	*Coreoperca whiteheadi* Boulenger, 1900		**LC**	*****		+			+	+	+		
(30).	**FAMILY LATIDAE**												
94.	*Lates calcarifer* (Bloch, 1790)		**NE**	*****		+			+			+	+
(31).	**FAMILY SERRANIDAE**												
95.	*Epinephelus awoara* (Tem. & Sch., 1842)		**DD**	*****									+
96.	*Epinephelus longispinis* (Kner, 1864)		**LC**	*****									+
(32).	**FAMILY TERAPONTIDAE**												

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
97.	*Terapon jarbua* (Forsskål, 1775)		**LC**	*		+						+	+
98.	*Pelates sexlineatus* (Quoy & Gaimard, 1825)		**LC**	*		+							+
(33).	**FAMILY APOGONIDAE**												
99.	*Apogon poecilopterus* Cuvier, 1828		**NE**										+
100.	*Ostorhinchus fasciatus* (White, 1790)		**NE**										+
(34).	**FAMILY SILLAGINIDAE**												
101.	*Sillago maculata* Quoy & Gaimard, 1824 Add		**NE**	*									+
102.	*Sillago sihama* (Forsskål, 1775)		**NE**	*									+
(35).	**FAMILY CARANGIDAE**												
103.	*Carangoides praeustus* (Bennett, 1830) Add		**NE**	*								+	+
104.	*Selaroides leptolepis* (Cuvier, 1833)		**NE**	*									+
105.	*Scomberoides lysan* (Forsskål, 1775) Add		**NE**										+
(36).	**FAMILY LEIOGNATHIDAE**												
106.	*Eubleekeria splendens* (Cuvier, 1829) Add		**LC**										+
107.	*Leiognathus equulus* (Forsskål, 1775)		**LC**			+							+
108.	*Leiognathus brevirostris* (Valenciennes, 1835) Add		**NE**										+
109.	*Secutor ruconius* (Hamilton, 1822)		**NE**										+
(37).	**FAMILY LUTJANIDAE**												
110.	*Lutjanus fulviflamma* (Forsskål, 1775) Add		**NE**	*									+
111.	*Lutjanus russellii* (Bleeker, 1849)		**NE**	*									+
112.	*Lutjanus fulvus* (Forster, 1801) Add		**NE**										+
(38).	**FAMILY GERREIDAE**												
113.	*Gerres limbatus* Cuvier, 1830		**LC**	*		+						+	+
114.	*Gerres decacanthus* (Bleeker, 1864)		**NE**			+						+	+
115.	*Gerres filamentosus* Cuvier, 1829		**LC**	*		+						+	+
(39).	**FAMILY HAEMULIDAE**												
116.	*Pomadasys maculatus* (Bloch, 1793) Add		**LC**	*									+
(40).	**FAMILY SCIAENIDAE**												
117.	*Argyrosomus pawak* Lin, 1940 Add		**NE**	*									+
(41).	**FAMILY MULLIDAE**												

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
118.	*Upeneus luzonius* Jordan & Seale, 1907 Add		**NE**										+
119.	*Upeneus subvittatus* (Tem. & Sch., 1843) Add		**NE**										+
120.	*Upeneus tragula* Richardson, 1846		**NE**										+
(42).	**FAMILY DREPANEIDAE**												
121.	*Drepane punctata* (Linnaeus, 1758)		**NE**	*									+
(43).	**FAMILY MONODACTYLIDAE**												
122.	*Monodactylus argenteus* (Linnaeus, 1758)		**NE**			+							+
(44).	**FAMILY MUGILIDAE**												
123.	*Liza affinis* (Günther, 1861)		**NE**	*		+							+
(45).	**FAMILY CICHLIDAE**												
124.	*Oreochromis niloticus* (Linnaeus, 1758)		**NE**	*	+	+				+	+	+	+
(46).	**FAMILY POMACENTRIDAE**												
125.	*Pomacentrus nigricans* (Lacepède, 1802) Add		**NE**										+
(47).	**FAMILY BLENNIIDAE**												
126.	*Omobranchus fasciolatoceps* (Richardson, 1846) Add		**LC**										+
(48).	**FAMILY CALLIONYMIDAE**												
127.	*Callionymus curvicornis* Valenciennes, 1837 Add		**NE**	*									+
128.	*Callionymus pleurostictus* Fricke, 1982 Add		**NE**										+
(49).	**FAMILY ODONTOBUTIDAE**												
129.	*Sineleotris chalmersi* Nichols & Pope, 1927		**LC**	*		+			+	+	+		
130.	*Sineleotris namxamensis* Chen & Kottelat, 2004		**DD**	*		+			+	+	+		
(50).	**FAMILY ELEOTRIDAE**												
131.	*Bostrychus sinensis* Lacepède, 1801	**CR**	**LC**	*		+						+	+
132.	*Butis butis* (Hamilton, 1822)		**LC**			+						+	+
133.	*Butis koilomatodon* (Bleek, 1849)		**NE**			+						+	+
134.	*Eleotris fusca* (Forster, 1801)		**LC**			+						+	+
135.	*Eleotris melanosoma* Bleeker, 1853		**LC**			+						+	+
(51).	**FAMILY GOBIIDAE**												
136.	*Chaeturichthys stigmatias* Richardson, 1844		**NE**									+	+
137.	*Oligolepis acutipennis* (Valenciennes, 1837)		**DD**			+					+	+	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
138.	*Oxyurichthys microlepis* (Bleek, 1849)		**NE**			+						+	+
139.	*Oxyurichthys tentacularis* (Valenciennes, 1837)		**NE**	*		+						+	+
140.	*Rhinogobius giurinus* (Rutter, 1897)		**LC**			+					+	+	
141.	*Rhinogobius leavelli* (Herre, 1935)		**LC**	*		+			+	+	+		
142.	*Tridentiger trigonocephalus* (Gill, 1859)		**NE**	*		+						+	
143.	*Ctenogobius brevirostris* Günther, 1861		**NE**									+	+
144.	*Papuligobius uniporus* Chen & Kottelat, 2003		**DD**	*		+				+	+		
145.	*Pseudapocryptes elongatus* (Cuvier, 1816)		**LC**	*		+						+	+
146.	*Acentrogobius caninus* (Valenciennes, 1837)		**NE**									+	+
147.	*Acentrogobius nebulosus* (Forsskål, 1775)		**NE**			+						+	+
148.	*Arcygobius baliurus* (Valenciennes, 1837)		**NE**									+	+
149.	*Favonigobius aliciae* (Herre, 1936)		**NE**			+						+	+
150.	*Glossogobius giuris* (Hamilton, 1822)		**LC**	*		+	+			+	+		
151.	*Glossogobius olivaceus* (Tem. & Sch. , 1845)		**LC**			+						+	+
152.	*Oplopomus oplopomus* (Valenciennes, 1837)		**NE**									+	+
153.	*Paragobiodon echinocephalus* (Ruppell, 1828)		**NE**			+						+	+
154.	*Parachaeturichthys polynema* (Bleek, 1853)		**NE**									+	+
155.	*Psammogobius biocellatus* (Valenciennes,1837)		**LC**			+						+	+
156.	*Yongeichthys criniger* (Valenciennes, 1837)		**NE**			+						+	+
(52).	**FAMILY SCATOPHAGIDAE**												
157.	*Scatophagus argus* (Linnaeus, 1766)		**LC**	*		+							+
(53).	**FAMILY SIGANIDAE**												
158.	*Siganus canaliculatus* (Park, 1797)		**NE**	*									+
159.	*Siganus punctatissimus* Fowler & Bean, 1929		**NE**										+
(54).	**FAMILY SPHYRAENIDAE**												
160.	*Sphyraena pinguis* Günther, 1874		**NE**	*									+
(55).	**FAMILY ANABANTIDAE**												
161.	*Anabas testudineus* (Bloch, 1792)		**DD**	*		+		+	+	+	+	+	+
(56).	**FAMILY OSPHRONEMIDAE**												
162.	*Macropodus opercularis* (Linneaeus, 1758)		**LC**			+		+	+	+	+	+	+

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
163.	*Macropodus spechti* Schreitmüller, 1936 Add		**DD**			+		+	+		+	+	+
164.	*Macropodus erythropterus* Frey. & Her., 2002 Add		**DD**			+		+	+		+	+	+
165.	*Trichopsis vittata* (Cuvier, 1831) Add		**LC**			+		+	+		+	+	+
166.	*Trichopodus trichopterus* (Pallas, 1770)		**LC**			+		+	+	+	+	+	**+**
(57).	**FAMILY CHANNIDAE**												
167.	*Channa striata* (Bloch, 1793)		**LC**	*****		+		+	+	+	+	+	+
168.	*Channa gachua* (Hamilton, 1822)		**LC**	*****		+	+		+	+			
XV.	**ORDER PLEURONECTIFORMES**												
(58).	**FAMILY PARALICHTHYIDAE**												
169.	*Paralichthys olivaceus* (Tem. & Sch., 1846) Add		**NE**			+							+
170.	*Pseudorhombus cinnamoneus* (T. & Sch., 1846) Add		**NE**										+
171.	*Pseudorhombus malayanus* Bleeker, 1865 Add		**NE**										+
(59).	**FAMILY BOTHIDAE**												
172.	*Engyprosopon longipelvis* Amaoka, 1969 Add		**NE**										+
(60).	**FAMILY SOLEIDAE**												
173.	*Aseraggodes xenicus* (Matsubara & Ochiai, 1963) Add		**NE**	*****		+							+
174.	*Heteromycteris japonicus* (Tem. & Sch., 1846) Add		**NE**			+							+
175.	*Solea ovata* Richardson, 1846		**NE**	*****		+							+
(61).	**FAMILY CYNOGLOSSIDAE**												
176.	*Cynoglossus cynoglossus* (Hamilton, 1822) Add		**NE**										+
177.	*Cynoglossus lingua* Hammilton, 1822 Add		**NE**										+
178.	*Cynoglossus puncticeps* (Richardson, 1846) Add		**NE**										+
XVI.	**ORDER TETRAODONTIFORMES**												
(62).	**FAMILY TRIACANTHIDAE**												
179.	*Triacanthus biaculeatus* (Bloch, 1786)		**NE**										+
(63).	**FAMILY MONACANTHIDAE**												
180.	*Paramonacanthus japonicus* (Tilesius, 1809) Add		**NE**										+
(64).	**FAMILY TETRAODONTIDAE**												
181.	*Lagocephalus sceleratus* (Gmelin, 1789) Add		**LC**			+							+
Total		**5**	**181**	**84**		**119**	**21**	**20**	**52**	**72**	**66**	**69**	**109**

Notes of table 3.1.: (1) Number the order; (2) Scientific name; (3) Species in the Vietnam Red Book 2007; (4) Species in the IUCN Red List of Threatened Species; (5) EV: Species with precious economic values; (6) IS: Invasive species; (7) Species distribute in the Phong Nha - Ke Bang National Park; (8) Species distribute inside cave habitat; (9) Species in rice farm; (10) Species in ponds, lakes, reservoirs; (11) Species found in upper stream; (12) Species found in middle; (13) Species found in down stream; (14) Species found in estuary; Add: Supplemental species in the Gianh River; Not Evaluated (NE); Data Deficient (DD); Least Concern (LC); Near Threatened (NT); Vulnerable (VU); Endangered (EN); Critically Endangered (CR).

List of supraspecific ranks (classes, orders, families and subfamilies) is sorted by William N. Eschmeyer and Jon David Fong 2015. Genera of subfamilies and species of genera is sorted by a to z.

It has been found that the taxonomic structure of ichthyofauna in the basin of river Gianh includes 16 orders, 64 families, 138 genera and 181 fish species (Tables 3.1 and 3.2).

Table 3.2. Structural components of fish in Gianh river basin

No	Order	Families	%	Genera	%	Species	%
1.	Order RAJIFORMES	1	1.6	1	0.7	1	0.6
2.	Order MYLIOBATIFORMES	1	1.6	1	0.7	1	0.6
3.	Order OSTEOGLOSSIFORMES	1	1.6	1	0.7	1	0.6
4.	Order ANGUILLIFORMES	3	4.7	5	3.6	5	2.8
5.	Order CLUPEIFORMES	2	3.1	5	3.6	5	2.8
6.	Order CYPRINIFORMES	4	6.3	37	26.6	53	29.3
7.	Order SILURIFORMES	5	7.8	8	5.8	11	6.1
8.	Order AULOPIFORMES	1	1.6	1	0.7	1	0.6
9.	Order ATHERINIFORMES	1	1.6	1	0.7	1	0.6
10.	Order BELONIFORMES	2	3.1	2	1.4	2	1.1
11.	Order SYNGNATHIFORMES	1	1.6	2	1.4	2	1.1
12.	Order SYNBRANCHIFORMES	2	3.1	3	2.2	3	1.7
13.	Order SCORPAENIFORMES	3	4.7	5	3.6	5	2.8
14.	Order PERCIFORMES	30	46.9	57	41.0	77	42.5
15.	Order PLEURONECTIFORMES	4	6.3	7	5.0	10	5.5
16.	Order TETRAODONTIFORMES	3	4.7	3	2.2	3	1.7
		64	100	139	100	18	100

The richest orders in viewpoint of number of species are: Perciformes (77 sp.), Cypriniformes (53 sp.), Siluriformes (11sp.) and Pleuronectiformes (10 sp.).

3.2. The distribution of fish species in the Gianh river basin

119 species have been certified in the National Park Phong Nha - Ke Bang which represent 65,7% from the total of species present in the basin of river Gianh (Table 3.1, Figure 3.2).

In order of descending according to taxonomic diversity value the estuary of the river should be mentioned (sea overspill area) with 119 fish species that represents 65.7% from the total of identified species in the basin. This empirically delimitated ecosystem represents an ecotone area which houses numerous fish representatives from different ecological groups (marine, estuary, fresh water, anadrome, catadrome, potmodrome species). There follows the

superior part of the river with 72 fish species that represents 39.8% and it is an area which abundance more in stenotopic species. Consequently two neighbouring areas follow: the inferior and middle area of the river with 69 (38.1%) and 66 (36.5%) fish species respectively. In the aquatic ecosystems such as ponds, natural and artificial lakes there have been attested 52 species which represent 28.7%, and in the cave ecosystems 21 (11.6%) fish species have been identified which are mainly stenotopic and have a great community value. The least specific diversity was attested in the artificial ecosystems of rice fields with 20 species (11%) which is a characteristic state for anthropic ecosystems with homogenious hydrobiotopes.

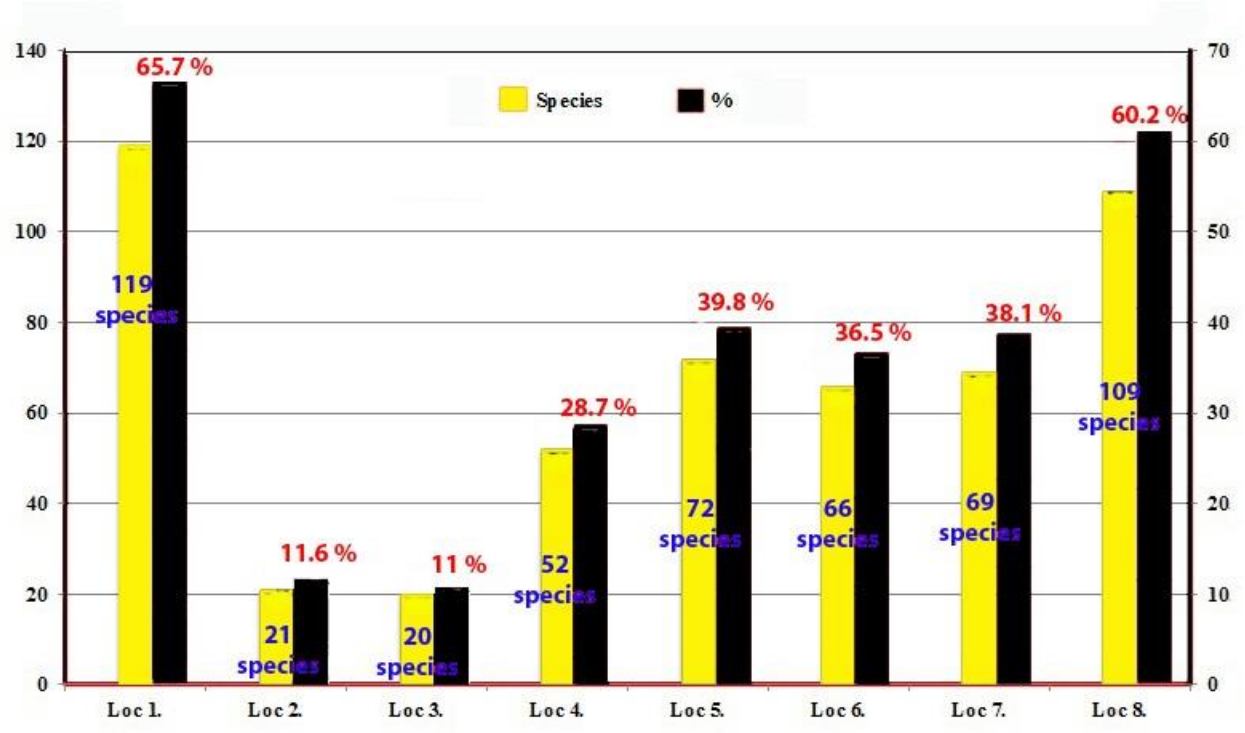

Fig. 3.2. The distribution of species in the basin study

Notes: (Loc. 1) Species distribute in the Phong Nha - Ke Bang National Park; (Loc. 2) Species distribute inside cave habitat; (Loc. 3) Species in rice farm; (Loc. 4) Species in ponds, lakes, reservoirs; (Loc. 5) Species found in upper stream; (Loc. 6) Species found in middle; (Loc. 7) Species found in downstream; (Loc. 8) Species found in estuary.

3.3. The rare and valuable economic fish species in Gianh river basin

3.3.1. The rare fish species in Vietnam Red Animals and the rare fish species in the IUCN Red List of Threatened Species

According to Vietnam Red Animals (2007) and based on species composition table. we determined that in Gianh river basin there are 5 fish species were recorded in the Red Book to be protected: *Anguilla marmorata* Quoy & Gaimard, 1824 (Vulnerable); *Clupanodon thrissa* (Linnaeus, 1758) (Endangered); *Konosirus punctatus* (Tem. & Sch., 1846) (Vulnerable); *Hypsibarbus annamensis* (Pel. & Che., 1936) (Vulnerable); *Bostrychus sinensis* Lacepède, 1801 (Critically Endangered). There should be mentioned the fact that the Red Book of Vietnam should be revised and completed with new fish species of national and international importance.

List of distributive fish species of Gianh river basin in the table 3.1 is recorded in the IUCN Red List of Threaten Species as below: Not Evaluated (NE): 78 species; Data Deficient (DD): 27 species; Least Concern (LC): 67 species; Near Threatened (NT): 5 species; Vulnerable (VU): 3 species; Endangered (EN): 1 species. the rate of bioconservation level was showed in the Fig. 3.3.1. in thesis.

In such a way we can affirm that the ichthyofauna in the basin of river Gianh is still "unknown and not fully studied", and half of the species belong to categories NE and DD, the region being a real treasure and cradle of animal and plant world at world level. The South-East Asian region is considered to be the centre of origin of many groups of fresh and sea water fish species.

3.3.2. Fish species having economic value

According to the method of determining fish species with economic value of the Mai Dinh Yen .... We identified in the Gianh river basin there are 84 species of economic value. List of economic species are shown in column 5 table 3.1. These species we encountered at all times of fieldwork with large output, and are frequently used, sold, exchanged, served food to tourists in Phong Nha - Ke Bang National Park. Thus we consider these 84 species of fish having economic value in Gianh River Basin.

3.3.3. Fish of invasive species and these species created a danger to humans

According to Nguyen Van Hao. Ichthyofauna of the Gianh river basin from Vietnam have 4 invasive species: *Cyprinus carpio* Linnaeus, 1758; *Ctenopharyngodon idella* (Val., 1844); *Hypophthalmichthys molitrix* (Valenciennes, 1844); *Oreochromis niloticus* (Linnaeus, 1758). But in this 4 species Kottelat said that *Hypophthalmichthys molitrix* (Valenciennes, 1844) is indigenous. According to our research species: *Cyprinus carpio* is indigenous.

According to the Nguyen Van Hao and our research shows that. In Gianh river basin have only 1 species *Lagocephalus sceleratus* secrete toxins endanger to humans. And 25 species created a danger of mechanics for humans such as: *Dasyatis sinensis Mystus gulio, Hemibagrus centralus, Tachysurus virgatus, Silurus asotus, Pterocryptis cochinchinensis, Clarias fuscus, Plotosus lineatus, Strongylura strongylura, Mastacembelus armatus, Sinobdella sinensis, Paracentropogon rubripinnis, Minous pusillus, Platycephalus indicus, Rogadius serratus, Sorsogona tuberculata, Terapon jarbua, Pelates sexlineatus, Scomberoides lysan, Callionymus curvicornis, Callionymus pleurostictus, Scatophagus argus, Siganus punctatissimus, Anabas testudineus, Triacanthus biaculeatus.*

3.4. Comparison of the composition of species in basins in North Central of Vietnam

The data in table 3.4 and figure 3.4.1 shows that the Ma river basin has the most diverse species composition (263 species, 167 genus, 58 family, 14 order), because the area of this basin is largest in all river basins in North Central, as well as its ecosystem is very diverse; next are

Huong river basin (186 species, 129 genus, 60 family, 17 order), Thach Han river (192 species, 128 genus,n56 family, 14 order), Nhat Le river (172 species, 131 genus, 59 family, 14 order), Gianh river (181 species, 139 genus, 64 family, 16 order) and Lam river (180 species, 110 genus, 41 family, 12 order). (Table 3.4.)

Table 3.4. Number of genera, families, orders and species of fish in the basins of the North Central.

No	Basin (★)	Basin area	Order	Family	Genus	Species	References
1.	Huong river	2830 km^2	17	60	129	186	259
2.	Thach Han river	2660 km^2	14	56	128	192	257
3.	Ben Hai river	964 km^2	12	45	78	100	257
4.	Nhat Le river	2647 km^2	14	59	131	172	35
5.	**Gianh river**	**4680 km2**	**16**	**64**	**139**	**181**	**Author**
6.	Lam river	17.730 km^2	12	41	110	180	34, 148
7.	Ma river	28.400 km^2	14	58	167	263	20

Notes: (★) Basins are arranged from south to north; Huong river basin in Thua Thien Hue province; Thach Han river basin in Quang Tri province; Ben Hai river basin in Quang Tri province; Nhat Le river basin in Quang Binh province; Gianh river basin in Quang Binh province; Lam river basin in Nghe Anprovince; Ma river basin in Thanh Hoa.

In comparison we can see that the number of species does not differ relevantly and a close correlation between basin area and ichthyofaunistic diversity is not noticeable but rather depends on the "concentration" degree of hydrobiotopic diversity on area unit.

It is important to be mentioned that, although the basin of river Lam has nearly the same dimensions as basin of river Ma, the number of species attested here is significantly lower. One of the causes can be the outdated results about the taxonomic composition in the basin of river Lam, the last investigations been performed in 1983 (Figure 3.4.1.).

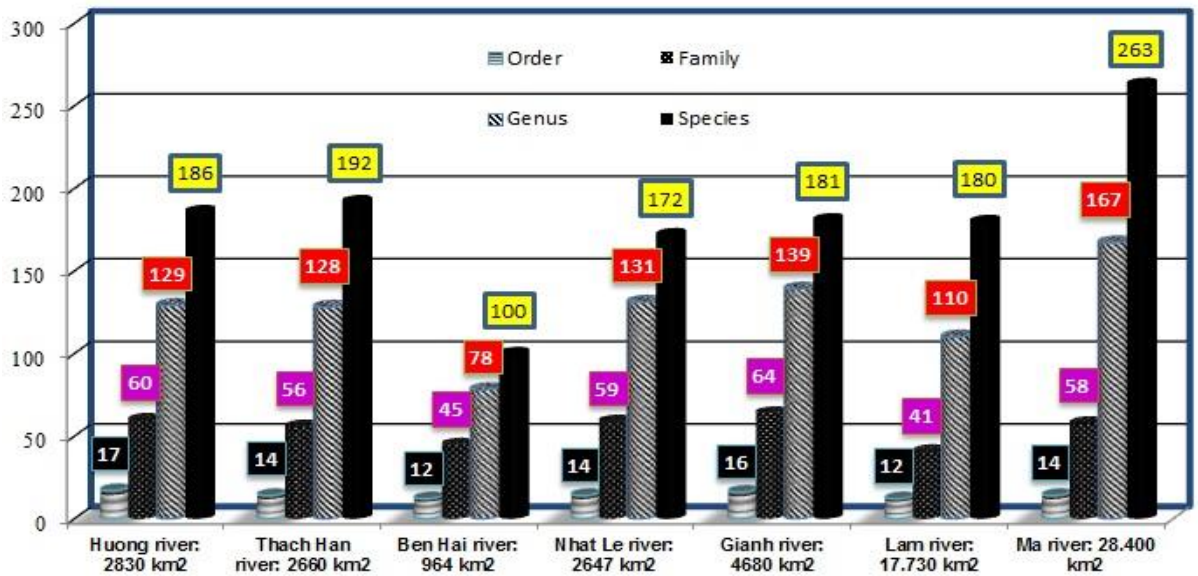

Fig. 3.4.1. Comparison of taxon between the basins in the North Central of Vietnam

The poorest is the basin of river Ben Hai with only 100 fish species because it is the smallest basin and is a hydrobiotope with a relative homogenious structure.

Comparative morphological aspects of the cosmopolitan taxon *Carassius auratus s. lato* from different points of its distribution area

Despite numerous scientific works dedicated to biology of *silver carp* its taxonomic status still remains not fully studied (Вехов, 2013).

According to affirmations made by some researchers (Golovinskaya et.al., 1965,Vasiliev, 1985; Cerfas, 1987; Abramenko, 1994, 2004) the unisexual polyploid *silver carp* (3n = 135 - 165) - *Carassius gibelio* Bloch, 1782, entered the aquatic basins of Europe in the XIXth century. Subsequently, at the beginning of 60s of XXth century, as a result of massive acclimatization works, the second bisexual species amphidiploid *Chinese carp* (2n = 98 - 100) - *Carassius auratus* Linnaeus, 1758 entered - at which in populations both sexes are represented approximately equally and which invaded shortly the entire Ponto-Caspian basin (Вехов, 2013; Межжерин, 2007; Абраменко, 2011). Current research at cariologic level demonstrated that, between the triploid and diploid, happens a change of genetic material with a current tendency of unidirectional transformation of triploid gynogenetic form into bisexual diploid (Apalikova, 2008).

That is why our goal was to perform a comparative morphological analysis of *silver carp* from Republic of Moldova (with an uncertain taxonomic status) with the sample from Vietnam which is unanimously recognized as Chines silver carp *Carassius auratus* Linnaeus, 1758 in order to confirm the hypothesis of the double entrance of the taxon in Europe.

There have been analysed 18 specimen of *Carassius auratus s.lato* caught in the lower part of river Prut and 8 specimens from the basin of river Gianh from Vietnam. It was found the existence of some differences in the formula of fins (D, A P, V), in the number of scales on the lateral line (1.1), in the number of transversal scales between the lateral line and origin of fins, etc., but the obtained results do not allow us to say with certainty that the taxon from lake Beleu is for sure *Carassius gibelio* Bloch, 1782 (Table 3.4.1.)

Table 3.4.1. Meristics of *Carassius auratus s.lato* and *Carassius auratus*

Meristics characters	***Carassius auratus s.lato* (Lower Prut, Republic of Moldova)**	***Carassius auratus* (control sp. Vietnam)**
D	III.18	III. 16 - 17
A	III.5	II-III.5
P	1.15 - 17	1.13 - 15
V	1.8	1.7 - 8
C	4.17	4.18
Csc	13	14 - 15
PrD	10 - 11	10 - 11
Sc	7	6 - 7
L.l.	29 - 30	30 - 32
TSD	6	6
TSV	4	6

During the comparative analysis of morphometric characters there also could be observed that in the majority of cases there are no significant differences and those which are present are determined rather by the expressed ecological polymorphism of the taxon and its large ecological valency which allows it to adapt easily in different types of aquatic ecosystems and to reach at present a cosmopolitan spreading (Table 3.4.2.).

Table 3.4.2. Morphometric of *Carassius auratus s.lato* and *Carassius auratus*

***Carassius auratus s.lato* (Lower Prut, Republic of Moldova), n = 18**					***Carassius auratus* (Vietnam), n = 8**				**t Student**
Metrics characters	**Mean**	**Min**	**Max**	**SD**	**Mean**	**Min**	**Max**	**SD**	
SL/Bd	2.43±0.01	2.29	2.55	0.066	2.48±0.01	2.34	2.71	0.119	**-2.14806**
SL/HL	3.21±0.02	3.08	3.39	0.083	3.14±0.02	2.97	3.59	0.200	2.009827
SL/Dhl	4.05±0.05	3.59	4.46	0.237	4.18±0.04	3.84	4.68	0.288	-1.83569
SL/Prdl	1.95±0.01	1.86	2.08	0.054	1.97±0.008	1.91	2.09	0.061	-1.265088
SL/Podl	6.06±0.08	5.37	6.61	0.366	6.22±0.04	5.61	6.58	0.309	-1.611576
SL/Lcp	7.62±0.14	6.47	8.53	0.579	7.12±0.108	6.23	8.06	0.760	**2.818163**
SL/Dcp	6.43±0.04	6.05	6.80	0.195	6.42±0.06	5.91	7.30	0.422	0.130484
HL/SnL	3.39±0.04	2.98	3.61	0.181	3.40±0.03	2.94	3.61	0.234	-0.181286
HL/Ed	3.55±0.05	3.14	3.89	0.217	4.07±0.04	3.73	4.64	0.288	**-7.780718**
HL/Iw	2.38±0.01	2.22	2.53	0.070	2.32±0.02	2.10	2.60	0.154	**2.162798**
HL/Po	2.07±0.01	1.96	2.18	0.075	2.05±0.008	1.98	2.16	0.056	1.010655
HL/Lcp	2.38±0.04	2.04	2.68	0.201	2.27±0.02	2.04	2.48	0.171	2.017775
HL/Dcp	2.00±0.06	1.89	2.15	0.067	2.05±0.02	1.87	2.35	0.148	-1.762762
Iw/Ed	1.49±0.02	1.30	1.70	0.107	1.77±0.02	1.52	2.21	0.209	**-7.09179**
Lcp/Dcp	0.85±0.01	0.74	1.00	0.073	0.91±0.01	0.78	1.01	0.090	**-2.729388**
P → V/V→A	0.68±0.007	0.61	0.73	0.032	0.60±0.01	0.43	0.68	0.078	0.96829

Note: $n_{(Moldova)}$ = 18 ind.; $n_{(Vietnam)}$ = 8 ind.; p=95% (0,05); g=24; t_{tabel}=2,064

These results, on the one hand suggest that the biology of silver carp is far from being fully described, and the majority of "current populations" represent a "genetic mix of predecessors penetrated from different regions", in some cases being more correct to mention the taxon as *Carassius auratus s. lato* or as *Carassius auratus* - complex (Bulat et al., 2014).

3.5. The causes of threats and proposals of conservation of fishery resources in Gianh river basin

3.5.1. The causes of threats to biodiversity of fish in the study area

- Method of fishing with high intense such as using explosives, poisons and electric shocks. The use of dynamite in fishing has been prohibited, but it still happens in some places. However, using of poisons and electric shocks is more common in the study area.
- Some exploitation of fishery resources are not properly also cause harm to the fish, such as the use of nets with small mesh sizes, fishing during the breeding season or at breeding sites are also the direct cause of depleting fish stocks.
- Due to the difficult economic life of local people, mainly ethnic minorities living on both sides of the basin, the lives of the people here are mostly self-sufficient so that their demand for food pressure fishery resources.

- The exploitation of natural resources affect the environment, such as exploiting minerals, gold, .and building dams, activities altering the flow in the basin are also the indirect cause to affect fish stocks.
- The problem of environmental pollution such as waste, unscientific construction works to serve tourists visiting the landscape of the Phong Nha - Ke Bang National Park especially the tourist route to caves also affect fish stocks.

3.5.2. The proposals for the protection and conservation of fish biodiversity in the study area

- Reconstruction and rehabilitation of species habitats with community interest and extinction of protected areas (maintenance of the banks, stabilizing bottom, planting trees along the riverbed, full restoration of natural conditions in caves, extending wetlands, etc.)
- Reduction of pollution (construction of new wastewater treatment plants and rebuilding of old ones, improving technologies for collection, storage and processing of waste in densely populated areas and those with touristic destination located along the river, springs cleaning, sanitation of banks, etc.)
- Stopping the issue of individual licenses for the exploitation of mineral resources in rivers and a strict control of enterprises that have this right. Limiting building dams and other hydraulic structures that affect the morphological integrity of riparian territories.
- Banning the destructive methods of catching fish such as light (as a source of enticement), toxic substances, explosives, small-meshed nets. Compliance to permitted times and places for fishing, the number of species fished, the minimum allowable size, etc.
- Saving juveniles from overflowing flood, a tighter control over penetration of alien species of fish and invertebrates, and on epidemiologic state, etc.
- Directed reproduction of indigenous fish species of community and functional importance, and systematic restocking of natural aquatic ecosystems with larvae and juveniles of these species.
- Improving living conditions of the local population, their active involvement in work and stimulating methods of voluntary ecological compliance (in competition with the restrictive ones) with the aim to protect and restore fish resources in the area.
- Strict scientific monitoring which provides a systematic assessment of ichthyofaunistic diversity and the structural-functional ichthyocenotic state, permanent perfection of biotechnologies of artificial reproduction of native species of fish (in recirculating systems), overseeing the acclimation works, a genetic control over breeders and over epidemiologic state in fishing communities.
- Dissemination of knowledge through educational courses on protection and sustainable exploitation of fishing resources among local people.

4. DESCRIPTION OF BASIC MORPHOLOGICAL CHARACTERISTICS OF FISH SPECIES IN GIANH RIVER BASIN.

In the study of the ichthyofaunistic diversity, a great importance in the correct determining of taxa and in the highlighting of phenotypic variability within population or between different populations, serves the classical method of metric and meristic analysis of individual characters. Any specialty determination is based on these measurements.

In case of some areas of the world, where the flora and fauna diversity in insufficiently studied, the description of these characters is of a paramount importance because they serve as supporting evidence in validation of species new for science. In determining some problem species in the present work there have been involved specialists of international level such as M. Kottelat and J. Freyhof.

The metric and meristic measurements of the caught individuals also permit the calculation of some body indices that help to assess the physiological state of the fish and of living conditions in various ecosystems. The necessity of these investigations arises particularly when comparing characters (or reports of characters) for populations of the same fish species that live in various types of aquatic ecosystems (e.g. lake and river) or, especially, in case of remote areas within the distribution area of the taxon (e.g. carp from Vietnam and Moldova).

Determination of variability of characters at collected individuals on the basis of measuring, counting, weighing and processing of obtained data through statistics of variations constitutes the area of competence of biometric studies, and the imposing number of individuals undergoing this analysis (1882 individuals) and identification of new species for science (from 181 identified species 3 are new for science: *Schistura kottelati* Tuan et all, 2015; *Carassioides phongnhaensis* Tu & Tuan, 2003 and *Cyprinus hieni* Tu & Tuan, 2003) show the high prestige of the work and a major impact of the obtained results for the entire scientific both national and international community.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. There have been attested 181 fish species that belong to 139 genera, 64 families and 16 orders in the hydrographic of Gianh river basin from Quang Binh province. There have been identified peculiarities of spatial distribution of 52 fish species from the basin of river Gianh.
2. Fish species *Schistura kottelati* Tuan et all, 2015; *Carassioides phongnhaensis* Tu & Tuan, 2003 and *Cyprinus hieni* Tu & Tuan, 2003 have been registered and approved as new species for science. There are still 3 unidentified species, the samples of which have already been sent to internationally known ichthyologists to confirm the proposed taxonomic status.
3. According to the IUNC in Gianh river basin there were identified 5 species is level (NT), 3 species is level (VU), 1 species is level (EN), 67 species is level (LC), 78 species is level (NE), 27 species with insufficient data (DD). According to national Red List there have been identified 5 fish species with rarity status.

4. Ichthyofauna of the Gianh river is unique as to its number of species, share of stenotopic species, and an impressive number of rare species which are important for community and those which were insufficiently studied (DD and NE according to IUCN). A major economic value present 84 fish species, and 3 species are allogenic invasive species and 26 species are potentially dangerous for humans.
5. There have been identified 119 species in the Phong Nha - Ke Bang National Park, 21 species have been attested in cave ecosystems, 20 species in rice fields, 52 species in ponds and dam lakes, 72 species in upstream, 66 species in the middle, 69 species in downstream and 109 species in estuary zone.
6. In order to protect efficiently a species and insure the success of its perpetuation in time and space the whole habitat should be protected. The scientific-practical recommendations for protection and improvement of fish resources in the Gianh river basin have an undeniable practical importance in the process of ecological reconstruction, bioindication and monitoring of well-being of aquatic ecosystems in the region.

RECOMMENDATIONS

1. Quang Binh People's Committees, functional departments and the administration of National Park should have coordination and directing the implementation of measures to protect fish resources in Gianh river basins including in the National Park.
2. The Department of Science and Technology, Department of Agriculture and Rural should have plans to invest in raising and taming rare fish recorded in Vietnam Red Book and species of economic value for protection.
3. Prohibit the exploitation of rare fish species recorded in the Vietnam Red Book is recommended with providing policy of sanctions in destructive
4. Research on biology and ecology of high economic value and aquaculture species in order to offer a scientific policy for management is necessary.
5. Government should support funding to investigate fish fauna in these areas. Especially, to those far away from the studied area where was dangerous and difficult to investigate before.
6. Regional economical activities as points of sources pollution in this basin need to be well controlled, strengthening awareness of biodiversity conservation when biodiversity law was approved by National Assembly, especially for fisher communities.
7. Training for local officers of fisheries in the Gianh River basins and forest guard of the Phong Nha - Ke Bang National Park about basic knowledge of fish fauna biodiversity conservation and sustainable exploitation of fish resources.

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ADNOTARE

Ho Anh Tuan "Ihtiofauna bazinul fluviului Gianh din Vietnam" Teza de doctor în ştiinţe biologice, Chişinău, 2015. **Structura tezei**. Introducere, 4 capitole, concluzii şi recomandări, bibliografia 326 surse, 150 pagini, 20 figuri, 7 tabele, 3 anexe (21 pagini, 193 figuri). Rezultatele obţinute sunt publicate în 15 lucrări ştiinţifice. **Cuvinte cheie.** Ihtiofauna Vietnamului, statut taxonomic, caractere meristice, caractere metrice, specii invazive, specii economic valoroase, valorificare sustenabilă. **Domeniul de studiu**. 165.03 Ihtiologie. **Scopul lucrării.** Evaluarea diversităţii ihtiofaunistice a bazinului fl. Gianh, completarea informaţiei ştiinţifice existente în domeniu şi elaborarea recomandărilor de protecţie şi utilizare durabilă a resurselor piscicole. **Obiective:** Inventarierea diversităţii ihtiofaunistice a bazinului fluviului Gianh din Vietnam; descrierea caracterelor morfometrice şi meristice a speciilor identificate, analiza repartiţiei spaţiale; identificarea speciilor economic valoroase de peşti, alogene invazive şi rare din bazinul fluviului Gianh.

Noutatea şi originalitatea ştiinţifică. Pentru prima dată s-a alcătuit o listă completă a speciilor de peşti din bazinul fluviului Gianh şi descrise caracterele morfologice ale taxonilor identificaţi. Au fost analizate particularităţile de distribuţie spaţială a speciilor de peşti din bazinul fluviului Gianh. Speciile au fost sistematizate conform valorii economice, originii şi statutului de raritate naţional şi internaţional. A fost identificate 3 specii noi pentru ştiinţă: *Schistura kottelati* Tuan ș.a, 2015; *Carassioides phongnhaensis* Tu & Tuan, 2003 şi *Cyprinus hieni* Tu & Tuan, 2003.

Problema ştiinţifică importantă soluționată în teză constă în actualizarea diversităţii ihtiofaunei şi a particularităţilor de repartiţiei a speciilor de peşti în bazinului fluviului Gianh, ceea ce a condus la elaborarea recomandărilor ştiinţifico-practice, în vederea conservării şi utilizării raţionale a fondului piscicol.

Semnificaţia teoretică. A fost actualizată informaţia ştiinţifică cu privire la diversitatea ihtiofaunei din bazinul fluviului Gianh, inclusiv Parcului Naţional Phong Nha - Ke Bang. Au fost identificate şi descrise 3 specii de peşti noi pentru ştiinţă. Au fost analizate caracterele metrice şi meristice ale speciilor capturate. Informaţia cu privire la speciile de peşti a fost sistematizată conform particularităţilor de repartiţie spaţială, valorii economice, originii şi statutului de raritate desemnat de Lista Roşie naţională şi internaţională (IUCN).

Valoarea aplicativă a lucrării. Rezultatele generalizate au servit ca bază ştiinţifică la elaborarea recomandărilor privind protecţia şi valorificarea durabilă a fondului piscicol din bazinul fluviului Gianh.

Implementarea rezultatelor. Rezultatele obţinute la tema tezei au fost implementate în cadrul instituţiilor de profil din Vietnam: Societatea Vânătorilor şi Pescarilor, Departamentul Protecţia Pădurilor, Departamentul Stiinţă şi Tehnologie, iar în procesul didactic la Universitatea Vinh din Vietnam şi Universitatea de Stat din Moldova.

РЕЗЮМЕ

Хо Ань Туан "Ихтиофауна бассейна реки Гйанх из Вьетнама". Диссертация на соискание ученой степени доктора биологических наук. Кишинэу, 2015

Структура работы: введение, 4 главы, выводы, 326 библиографических источников, 150 основных страниц, 20 таблиц, 7 рисунков, 3 приложения (21 страниц, 193 таблиц). По теме диссертации опубликовано 15 работ.

Ключевые слова: Ихтиофауна Вьетнама, таксономический статус, морестические и метрические признаки, инвазивные виды, промысловоценные виды, устойчивое использование рыбных ресурсов. **Область исследований:** 165.03 ихтиология

Цель: Оценка разнообразия рыб в бассейне реки Гйанх из Вьетнама и разроботка рекомендаций по сохранению и устойчивому использованию рыбных ресурсов.

Задачи работы: Инвентаризация таксономического разнообразия ихтиофауны бассейна реки Гйанх из Вьетнама; описание метрических и морестических признаков видов рыб в зоне исследований; анализ пространственного распределения, промысловой ценности, происхождения и редкости видов рыб в бассейне реки Гйанх.

Научная новизна и оригинальность. Впервые составлен полный список таксономического разнообразия ихтиофауны бассейна реки Гйанх, описаны метрические и морестические признаки видов рыб в зоне исследований; анализировано пространственное распределение, промысловая ценность, идентифицированы чужеродные виды рыб, и составлен список редких видов рыб включённых в Красную книгу Вьетнама (2007) и Международный Красный Список (МСОП). Было идентифицировано 3 новых видов для науки: *Schistura kottelati* Tuan и др., 2015; *Carassioides phongnhaensis* Tu & Tuan, 2003 и *Cyprinus hieni* Tu & Tuan, 2003.

Важная научная задача, решённая в данной работе, состоит в том, что было актуализировано видовое разнообразие и особенности распределения видов рыб в бассейне реки Гйанх из Вьетнама, что позволило разработать научно-практические рекомендаций по сохранению и рациональному использованию рыбных ресурсов.

Теоретическое значение работы. Было актуализировано разнообразие ихтиофауны бассейна реки Гйанх из Вьетнама, включительно Национального Парка Фонгня-Кебанг. Идентифицировано 3 новых для науки видов рыб. Описаны метрические и морестические признаки всех видов рыб в зоне исследований. Информация о видах рыб была систематизирована в соответствии с особенностями пространственного распределения, экономической ценности, происхождения и статуса редкости согласно Красной Книге Вьетнама и Международным Красным списоком (МСОП).

Практическое значение. Полученные результаты послужили научной основой для разработки рекомендаций по сохранению и устойчивому использованию рыбных ресурсов бассейна реки Гйанх.

Внедрение результатов. Результаты исследований были внедрены: Обществом Охотников и Рыболовов Вьетнама, Департаментом по Охране Лесного Хозяйства, Департаментом Науки и Техники, а также в учебной программе Университета Винь из Вьетнама и Молдавского Государственного Университета.

SUMMARY

Ho Anh Tuan "**Ichthyofauna of the Gianh river basin from Vietnam**". Thesis of a Doctor in Biology, Chisinau, 2015. Thesis structere: introduction, 4 chapters, conclusions and recommendations, 326 cited literature, 150 pages, 20 figures, 7 tables, 3 annexes (21 pages 193 figures). The obtained results have been published in 15 scientific works and 3 projects. **Key words:** Vietnam ichthyofauna, taxonomic status, meristic character, metric character, invasive species, economically valuable species, sustainable valorification. **The domain of study**: 165.03. Ichthyology.

Research purpose. Evaluation of the ichthyofaunistic diversity in the basin of river Gianh, and elaboration of recommendations for protection and durable use of fish resources.

Objectives. Inventory of fish fauna diversity in the basin of river Gianh from Vietnam; description of morphometric and meristic characters of the identified species; analysis of spatial repartition; identification of fish species with high economic value, of the invasive and rare alogens ones in the basin of river Gianh.

Novelty and scientific originality. For the first time there has been composed a complete list of fish species from the basin of river Gianh and there have been described the morphological characters of identified taxons. There have been analyzed peculiarities of spatial distribution of the fish species in the basin of river Gianh. The species have been systematized according to their economic value, origin, and national and international status of rarity. There have been identified 3 new species for research: *Schistura kottelati* Tuan et al., 2015; *Carassioides phongnhaensis* Tu & Tuan, 2003 and *Cyprinus hieni* Tu & Tuan, 2003.

The important scientific problem solved in the thesis consists in the actualization of ichthyofauna diversity and the peculiarities of distribution of fish species in the basin of river Gianh which led to the elaboration of scientific-practical recommendations for the conservation and rational use of fisheries.

Theoretical significance. The scientific information about the diversity of ichthyophauna in the basin of river Gianh and the National Park Phong Nha - Ke Bang was updated. There were identified and described 3 new fish species for science. There were analized the metric and meristic characters of the caught species. The information about the fish species has been systematized according to peculiarities of spatial distribution, economic value, and origin and rarity status designated by national and international Red List (IUCN).

Practical value of the work. The obtained results served as scientific basis for developing recommendations for the protection and sustainable use of fish resources in the basin of river Gianh.

Implementation of the results. The obtained results on the topic of the thesis were implemented in specialized institutions of Vietnam: Society of Hunters and Fishermen, Forestry Protection Department, Department of Science and Technology, and also in the teaching process at University Vinh from Vietnam and Moldova State University.

HO ANH TUAN

ICHTHYOFAUNA OF THE GIANH RIVER BASIN FROM VIETNAM

SPECIALTY: 165.03. ICHTHYOLOGY

Abstract of the doctoral thesis in Biological Sciences

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