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Diversity and Conservation of Korean Marine Fishes

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ABSTRACT **Environmental differences of each sea around the Korean Peninsula in terms of factors including topography and complexity of sea current may influence species and genetic diversity of marine fishes. Fish are naturally abundant in the frontal area where various currents or water masses meet. However, this food resource is prone to human overexploitation, threatening the marine ecosystem. New fisheries resources management strategies are needed. Such strategies require information about population structure obtained through morphological and genetic methods.**

Key words : Korea, marine fish, species diversity, genetic diversity, species conservation, management unit

INTRODUCTION

The Korean Peninsula is bounded by water on the east (East Sea), west (Yellow Sea), and south (East China Sea). The collision of diverse water masses between the Yellow Sea and East China Sea produces a good fishing ground (Liu *et al.*, 1990; Jin *et al.*, 2003; Choi *et al.*, 2004; Choi *et al.*, 2008). Especially, commercially important fishes such as *Larimichthy polyactis* and *Trichiurus lepturus* are caught at the southwest sea of Jeju Island, perhaps due to the gathering effect of prey (*Benthosema pterotum*) by a strong cyclonic eddy (Sassa *et al.*, 2008). These good fishing grounds around the Korean Peninsula are under threat from human overexploitation, which has imperiled both the diversity and abundance of the fishery resource.

The Korean fishery has been in decline since the 1980s and the catch per unit effort (CPUE) has been trending downwards continuously from the middle of 1970s. In addition, the geographical extent of the fishing grounds has been reduced as the result of Korea-Japan and Korea-China fisheries negotiation. A new approach to the fisheries resources management is needed.

A population structure-based approach that uses morphological and genetic methods may help define the management unit and/or its range. If the boundary among various regional populations within species is not clear, it is difficult to evaluate the status of unit resource (Waldman, 2005). By definition, a fish population: (1) has a unique life cycle of its own including a particular spawning ground, (2) experiences an unique demographic effect, (3) is a part of the wider environment whose morphological and genetic characteristics are changed by a partial or complete separation from the environment, and (4) responds based on characteristics of its abundance and life cycle (Waldman, 2005). Clarification of population structure based on morphological and genetic methods will more clearly define the management unit and its range. This approach has traditionally focused on widely distributed species such as *Thunnus thynnus thynnus* for the purpose of appropriate management for each population (Carlesson *et al.*, 2004). Other studies have addressed characteristics of each population for migratory fish species including *Scomber japonicus* (two populations), *Trichiurus lepturus* (two populations), *Trachurus japonicus* (three populations), *Larimichthys polyactis* (three populations) and *Pampus echinogaster* (two populations) in Japan, with the aim of increasing the prediction of resource fluctuation (as an example, see Yamada *et al.*, 2007). In Korea, the genetic variation of migratory fish populations has been investigated for *Ammodytes personatus* (Kim *et al.*, 2006, 2008), *Arctoscopus japonicus* (Lee, 2008) and *Larimichthys polyactis* (Kim *et al.*, In progress). Studies such as these are clarifying the degree of genetic exchange among fish species inhabiting each coastal area, which will in turn help best manage the fisheries resource of each coastal area.

The present review provides information on characteristics of each sea around the Korean Peninsula, species

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composition of fish inhabiting each sea and changing research in fish diversity, with the aim of influencing further study that will most effectively manage the Korean fisheries resource.

CHARACTERISTICS OF THE EACH SEA OF KOREA

The mean water depth varies from a maximum of 1,684 meters in the East Sea to only 44 meters in the West Sea. In the middle part of the East Sea, there is the stable polar front formed by the intersection of the East Korean Warm Current (EKWC), which is higher in temperature and salinity, and the lower temperature and salinity North Korean Cold Current (NKCC). In the East Sea, there is an unstable front formed by the Tsushima Warm Current (TWC) and another warm current (Gong and Son, 1982). In the West Sea, the Yellow Sea Bottom Cold Water (YSBCW) is characterized by low temperature, low salinity and abundant suspended solids under the influence of influx water from the Yangtze River (Choi *et al.*, 2008). The South Sea and Jeju Island are directly affected by the high temperature and salinity TWC separated from Kuroshio Warm Current (KWC). In particular, Jeju Island is influenced by diverse water masses that include the Chinese Continental Coastal Water (CCCW), YSBCW and Korean Coastal Water (Choi *et al.*, 2003). The diverse topography and characteristics of these currents are the origin of fish diversity in the Korean Peninsula.

SPECIES DIVERSITY OF MARINE FISHES IN KOREA

There are 439 known fish species in the East Sea, including Perciformes (43% of the total species), Scorpaeniformes (19%), Pleuronectiformes (7%) and Tetraodontiformes (6%) (Kim and Nam, 2003). These studies were mostly carried out around Pohang except for one (Ryu *et al.*, 2005) that reported 59 species recovered using set and gill nets in Goseong, Kangwon Province, in the far north of South Korea (Table 2). All studies were conducted at depths of <50 m; virtually nothing is known of deep sea fish species in the East Sea. The fish fauna in Heunghae north to Pohang is almost the same with that in the South Sea, with the exception of *Alcichthys alcicornis* (Hwang *et al.*, 1997). However, the fish fauna in Goseong is clearly different from that in the South Sea. Ryu *et al.* (2005) reported frequent occurrence of cold sea water fishes such as *Pleurogrammus azonus*, *Podothecus sachi*, *Eurymen gyrinus*, Cottidae spp. Therefore, it is highly possible that there may be two ecosystems clearly distinguished in the East Sea, which is supported by population structure of *Ammodytes personatus* (Kim *et al.*, 2006) and *Arctoscopus japonicus* (Lee, 2008).

In the West Sea, there are 339 known fish species including Perciformes (41% of the total species), Scorpaeniformes (12%), Pleuronectiformes (9%) and Tetraodontiformes (7%) (Lee, 2003). The identity and prevalence of the dominant species is similar to that in the East Sea. Studies on the fish fauna in the West Sea have been carried out from Asan Bay south to Youngkwang (Table 2). In Youngkwang, trawl studies conducted in 1986 identified *Johnius belengeri*, *Chaeturichthys stigmatias* and *Pennahia argentata* as the dominant species. Another trawl study of the same region carried out in 1995 found *Johnius belengeri*, *Cynoglossus joyneri* and *Collichthys niveatus* to be dominant (Table 2). The diminished catch of *Pennahia argentata* might be a manifestation of climate-related sea change, although this remains speculative. Nonetheless, long-term monitoring of fish fauna is needed to clarify the influence of global warming. Some Korean endemic species such as *Ophichthus rotundus*, *Sebastes koreanus*, *Repomucenus leucopoeilus* and *Acentrogobius pellidebilis* reside in the West Sea, of which *O. rotundus* and *R. leucopoeilus* are registered as endangered species. The high occurrence rate of endemic species in the West Sea may have resulted from the origin of this body of water. During the ice age that occurred about 15,000 years ago, the sea level decreased and the present-day West Sea disappeared. About 10,000 years ago, the sea was re-established as the ice disappeared. This cyclical pattern was repeated through the various ice ages (Petit *et al.*, 1999), which may have been pivotal in speciation (Kitamura, 2004).

In the South Sea, there are 301 known species including Perciformes (41% of the total species), Scorpaeniformes (15%), Pleuronectiformes (10%) and Tetraodontiformes (7%) (Han, 2003). This pattern of species prevalence is similar to the East and West Seas. Only one species, *Raja koreana* is considered to be a South Sea endemic species. Since it has become recently available for food instead of *Raja pulchra*, it requires special management (Kim *et al.*, 2005). Compared to the East and West Seas, more is known for South Sea fish fauna (Table 3). In 1998, the fish fauna at Gadeok-do was investigated using four fishing gears (otter trawl, three sides fyke net, crab pots and bottom gill net). A total of 136 and 110 species were collected from three side fyke net and bottom gill net, respectively, but only 49 species were collected from the otter trawl and crab pots (Table 3), indicating the necessity to investigate fish fauna using appropriate fishing gear or more than two fishing gears (Ryu *et al.*, 2005).

In Jeju Island, there are 612 known fish species including Perciformes (56% of the total species), Scorpaeniformes (11%), Tetraodontiformes (7%) and Rajiformes (3%). This differs somewhat from other locales; of note, subtropical fish species were very frequently found (Kim

Table 1. The list of unrecorded fish species from Korea during past 10 years

Species name	Korean name	Sampling location	Reference
Odontobutis obscura	남방동사리	Geoje	Chae, 1999
Decapterus macrosoma	긴가라지	**Jeju Island**	Kim *et al.*, 1999
Carangoides orthogrammus	노랑점무늬유전갱이	**Jeju Island**	Kim *et al.*, 1999
Ariosoma major	큰흰붕장어	Busan	Lee and Ju, 1999
Rhynchoconger ectenurus	검은꼬리붕장어	Buan, Jeonbuk	Lee and Ju, 1999
Chaunax abei	점씬벵이	Geoje	Lee and Kim, 1999
Bembrops curvatura	줄굽은눈퉁이	Geoje	Lee and Kim, 1999
Opistognathus iyonis	흑점후악치	Tongyoung, Gyongnam	Myoung *et al.*, 1999
Naso lituratus	제주표문쥐치	**Jeju Island**	Lee *et al.*, 2000
Dysomma anguillare	긴꼬리장어	Buan, Jeonbuk	Lee and Kim, 2000
Pleurogrammus monopterygius	단기임연수어	Gosung, Gangwon	Youn and Kim, 2000
Lophiodes insidiator	용아귀	Busan	Youn *et al.*, 2000
Halieutaea fumosa	민부치	Busan	Youn *et al.*, 2000
Decapterus akaadsi	붉은가라지	Busan	Kim *et al.*, 2001
Sardinella lemuru	바리밴댕이	**Jeju Island**	Kim *et al.*, 2001
Brotula multibarbata	수염첨치	Busan	Kang *et al.*, 2002
Neosynchiropus ijimai	연지알롱양태	**Jeju Island**	Choi *et al.*, 2002
Polymixia japonica	등점은눈돔	**Jeju Island**	Koh and Moon, 2003
Eviota prasina	남방풀비늘망둑	**Jeju Island**	Kim and Go, 2003
Epinephelus heniochus	볼줄바리	**Jeju Island**	Yagishita *et al.*, 2003
Pseudolabrus eoethinus	무점황놀래기	**Jeju Island**	Kim and Go, 2003
Takifugu oblongus	폭포무늬복	East China Sea	Han *et al.*, 2003
Gephyroberyx darwinii	납작금눈돔	**Jeju Island**	Kim *et al.*, 2004
Ophidion asiro	제주바다메기	**Jeju Island**	Lee and Joo, 2004
Eviota melasma	흑점풀비늘망둑	**Jeju Island**	Kim *et al.*, 2005
Phtheirichthys lineatus	열줄빨판이	Wooljin, Gyongbuk	Lee and Ju, 2006
Apogon cookii	다섯줄얼게비늘	Dok Island	Myoung *et al.*, 2006
Lycodes sadoensis	사도먹갈치	Youngdeok, Gyongbuk	Kim *et al.*, 2006
Lycodes japonicus	무늬가시치	Gangwon	Kim *et al.*, 2006
Lycodes pectoralis	북갈치	Wooljin, Gyongbuk	Kim *et al.*, 2006
Lycodes sigmatoides	굴곡무늬치	Gangwon	Kim *et al.*, 2006
Asterropteryx semipunctata	청별망둑	**Jeju Island**	Kim *et al.*, 2007
Hypsagonus corniger	가시줄고기	Gangwon	Lee and Jeon, 2007
Istiblennius dussumieri	검은점베도라치	**Jeju Island**	Kim and An, 2007
Acanthurus nigricauda	양쥐돔	Busan	Kim *et al.*, 2007
Chelidoperca pleurospilus	별각시돔	**Jeju Island**	Park *et al.*, 2007
parapercis muronis	다섯줄양동미리	**Jeju Island**	Park *et al.*, 2007
Solenostomus cyanopterus	유령실고기	Youngdeok, Gyongbuk	Yim *et al.*, 2007
Psettina tosana	사량넙치	Tongyoung, Gyongnam	Lee and Lee, 2007
Pseudorhombus oculocirris	남해넙치	Samchonpo, Gyongnam	Lee and Lee, 2007
Naso hexacanthus	남방표문쥐치	**Jeju Island**	Kim *et al.*, 2008
Zoarces elongatus	무점등가시치	Byunsan, Jeonbuk	Ko and Park, 2008
Opistognathus hongkongiensis	줄후악치	**Jeju Island**	Park *et al.*, 2008
Carangoides oblongus	채찍유전갱이	**Jeju Island**	Kim *et al.*, 2008
Acanthocepola indica	남방홍갈치	Tongyoung, Gyongnam	Park *et al.*, 2008
Aspasma minima	꼬마학치	**Jeju Island**	Han *et al.*, 2008
Muraenichthys gymnopterus	갯물뱀	Inchon	Kim *et al.*, 2008
Lactoria fornasini	줄무늬뿔복	**Jeju Island**	Kim *et al.*, 2008

and Lee, 1994). As the surface water temperature increases, subtropical fish species become more prevalent in the South and East Seas including the waters around Jeju Island. The number of newly reported (unrecorded) species around the Korean Peninsula has been consistently increasing over the past 10 years (Table 1). A total of 47 species were recorded in the Korean Journal of Ichthyology between 1999 and 2008, representing a mean of 4.7 unrecorded species every year. The number of unrecorded species (20) peaked in the waters surrounding Jeju Island, representing 42.6% of the total number of species. Unrecorded species tend to be most prevalent in the area

Table 2. List of fish fauna investigation from the East Sea and West Sea (=Yellow Sea) of Korea

Area	Period (times)	Gear	No. species	Dominant species	References
Ulsan	1998 (6)	Set net	89	*Scomber japonicus, Trachurus japonicus, Thamnaconus modestus*	Han *et al.* (2002)
Heunghae	1989 (4), 1990 (3)	Three sides fyke net	28	*Sebastes inermis, Stephanolepis cirrhifer, Hexagrammos agrammus*	Hwang *et al.* (1997)
Youngil-man	1991 (4)	Trawl	59	*Repomucenus lunatus, Tridentiger trigonocephalus, R. huguenini*	Lee (1999)
Middle East Sea	2004 (3), 2005 (1)	Gill net	33	*Sebastes inermis, Alcichthys alcicornis, Liparis tanakai*	Yoo *et al.* (2005)
Middle East Sea	2004 (3), 2005 (1)	Set net	36	*Seriola quinqueradiata, Trachurus japonicus, Gadus macrocephalus*	Yoo *et al.* (2005)
Pohang	1998. 1～12 (12)	Three sides fyke net	58	*Sebastes inermis, Halichoeres poecilopterus, Stephanolepis cirrhifer*	Han *et al.* (2002)
Ulreung-do	2004 (2)	Diving	45	Scorpaenidae, Labridae, Cottidae	Myoung *et al.* (2005)
Youngil-man	2001. 1～2002. 12 (24)	Gill net	73	*Engraulis japonicus, Pleuronectes yokohamae, Thamnaconus modestus*	Hong *et al.* (2008)
Weolsung	2006 (4), 2007 (4)	Stake net, lift net	27	*Furcina osimae, Chaenogobius gulosus, Chaenogobius annularis*	Choi *et al.* (2008)
Gunsan	1992. 8～1993. 7 (12)	Bottom trawl *et al.*	98	*Cynoglossus joyneri, Repomucenus ornatipinnis, Harengula zunasi*	Yoo and Choi (1993)
Younggwang	1986 (6, 8, 11), 1987～3 (4)	Trawl	33	*Johnius grypotus, Chaeturichthys stigmatias, Argyrosomus argentatus*	Lee and Gil (1998)
Gogunsangundo	1997. 4～1997. 11 (9)	Long bag set net	53	*Pholis fangi, Engraulis japonicus, Ammodyres personatus*	Hwang (1998)
Younggwang	1995. 4～1996. 1 (10)	Stow net	64	*Thryssa kammalensis, Johnius grypotus, Leioganthus nuchalis*	Hwang *et al.* (1998)
Younggwang	1995 (3)	Trawl	46	*Johnius grypotus, Cynoglossus joyneri, Collichthys niveatus*	Hwang *et al.* (1998)
Chonsu-man	1992. 3～1993. 1 (11)	Trawl	63	*Engraulis japonicus, Ammodytes personatus, Enedrias fangi*	Lee (1998)
Asan-man	1997 (10, 12)～ 1998 (2, 4, 6, 8) (6)	Seines, beam trawl	43	*Favonigobius gymnauchen, Kareius bicoloratus*	Hwang and Lee (1999)
Taean	1996. 5～1999. 7	Set net, gill net, pot	73	*Chasmichthys gulosus, Chasmichthys dolihcognathus, Sebastes schlegeli*	Lim and Choi (2000)
Gum R. estuary	2003. 2～12 (11)	Bag net	73	*Sardinella zunasi, Konosirus punctatus, Synechogobius hasta*	Hwang *et al.* (2005)
Taean	2005 (8)	Seine net *et al.*	27	*Favonigobius gymnauchen, Luciogobius guttatus, Chaenogobius gulosus*	Choi and Jang (2007)

strongly affected by the TWC. For example, 12 unrecorded species (25.5% of the total) were noted in the eastern area of the South Sea (Busan, Geoje and Tongyoung), and eight species (17%) were noted in the central area of the East Sea (Kangwon and Kyongbuk) (Table 1). Despite such data, few specimens have been preserved, which have limited taxonomic studies. Systematic studies aimed at the collection, management and preservation of specimens are needed (Kim and Go, 2003).

CHANGE IN FISH DIVERSITY RESEARCH

Taxonomy based on morphology has several drawbacks. First, fishes are classified depending on subjectivity and personal experience of ichthyologists. Second, it can be difficult to collect data about homology of characters. Third, few characters are available in phylogenetic estimations.

The morphology-based approach has changed following the publication of the structure of DNA (Watson and Crick, 1953). Subsequently, the extensive genetic data produced was efficiently managed through the establishment of Cladistics and with refinements in computer technology (Kim, 2000). As example, 14 substitution models have been developed for sequence analysis and a Modeltest program was developed enabling the selection of an optical model (Posada and Crandall, 1998). The Likelihood method has so-far proven to be the most robust optical model (Whelan *et al.*, 2001).

How has the morphology-based taxonomic system been changed through application of DNA? In the past, the family Salangidae was considered as a sister group of the families Galaxiidae, Osmeridae or the genus *Mol-*

Table 3. List of fish fauna investigation from the South Sea (=East China Sea) including Jeju Island of Korea

Area	Period (times)	Gear	No. species	Dominant species	References
Shinsu-do	1984. 2～1985. 1 (12)	Gill net	32	*Hexagrammos otakii, Hexagrammos agrammus, Sebastes inermis*	Kim and Kang (1991)
Kwangyang	1990. 2～1990. 12 (11)	Bottom trawl	54	*Leiognathus nuchalis, Konosirus punctatus, Liparis tanakai*	Cha and Park (1997)
Namhae-do	1989. 5～1990. 4 (12)	Otter trawl	64	*Acentrogobius pflaumii, Chaeturichthys hexanema, Chaeturichthys sciistius*	Huh and Kwak (1998)
Namhae-do	1989. 5～1990. 4 (12)	Bag net	56	*Engraulis japonicus, Conger myriaster, Sardinella zunasi*	Huh and Kwak (1998)
Geoje-do	1996. 2～10 (9)	Gill net	43	*Stephanolepis cirrhifer, Ditrema temmincki, Hexagrammos otakii*	Cha (1999)
Nakdong R.	1987. 2～1988. 1 (12)	Otter trawl	100	*Repomucenus valenciennei, Pholis fangi, Leiognathus nuchalis*	Huh and Chung (1999)
Yongwon	1998. 1～12 (12)	Beach scines	34	*Hyporhamphus intermedius, Favonigobius, Pholis nebulosa*	Lee *et al.* (2000)
Gadeok-do	1998. 1～1998. 12 (12)	Otter trawl	110	*Repomucenus valenciennei, Thryssa kammalensis, Leiognathus nuchalis*	Huh and An (2000)
Goheung	1999 (4)	Otter trawl	123	*Leiognathus nuchalis, Konosirus punctatus, Engraulis japonicus*	Han *et al.* (2001)
Wando	1999～2001 (5, 6, 7, 8, 9, 10)	Long bag set net	73	*Engraulis japonicus, Trichiurus lepturus, Hapalogenys mucronatus*	Kim *et al.* (2002)
Gadeok-do	1998. 1～1998. 12 (12)	Three sides fyke net	136	*Trachurus japonicus, Konosirus puctatus, Mugil cephalus*	Huh and An (2002)
Gadeok-do	1998. 1～1998. 12 (12)	Crab pots	49	*Conger myriaster, Sebastes inermis, Hexagrammos otakii*	Huh and An (2003)
Doam-man	2001. 3～2002. 2 (12)	Shrimp beam trawl	53	*Chaeturichthys hexanema, Cynoglossus robustus, Acanthogobius flavimanus*	Kim *et al.* (2003)
Gadeok-do	1998. 1～1998. 12	Bottom gill net	49	*Limanda yokohamae, Cynoglossus abbreviatus, Ditrema temmincki*	Huh and An (2002)
Yosu	2001. 4～2001. 10 (7)	Set net	52	*Engraulis japonicus, Trachurus japonicus, Trichiurus lepturus*	Kim *et al.* (2003)
Dolsan-do	2003. 3～2004. 2 (12)	Fyke net	48	*Konosirus punctatus, Mugil cephalus, Liparis tanakai*	Jeong *et al.* (2005)
Dolsan-do	2001～2002 (7), 2003 (9)	Set net	40	*Sardinella zunasi, Engraulis japonicus, Scomberomorus niphonius*	Hwang *et al.* (2006)
Jindong Bay	2002. 1～12 (12)	Beam trawl	26	*Hexagrammos otakii, Acanthopagrus schlegeli, Lateolabrax japonicus*	Kwak *et al.* (2006)
Masan-man	2004 (2), 2005 (5), 2006 (1)	Drift gill net	28	*Konosirus punctatus, Mugil cephalus, Engraulis japonicus*	Huh and Kwak (2007)
Geomo-do	2003. 5～2004. 4 (12)	Fyke net	53	*Acanthopagrus schlegeli, Konosirus punctatus, Apogon lineatus*	Hwang and Yoo (2008)
Mun-sum	1994 (4)	Diving, fishing	79	Pomacentridae, Labridae, Scorpaenidae	Myoung (1997)
Hamduck	1993. 5～1994. 5 (13)	Beam trawl	58	*Aulichthys japonicus, Syngnathus schlegeli, Plotosus lineatus*	Go and Cho (1997)
Southern Jeju	1996. 7～2000. 12 (54)	Fishing, fishing boat	140	Scorpaenidae, Tetraodontidae, Carangidae	Choi *et al.* (2003)
Cheonjeyeon	2004 (1～9)～ 2007 (1～8) (17)	Net	14	*Plecoglossus altivelis altivelis, Mugil cephalus, Anguilla japonica*	Hwang *et al.* (2008)
Gwideok	2004. 4～2004.12 (9)	Set net	17	*Trachurus japonicus, Siganus fuscescens, Seriola dumerili*	Cha *et al.* (2008)

lotus by virtue of its morphology (see Fu *et al.*, 2005). However, Fu *et al.* (2005) suggested rearrangement of the family Salangidae into the family Osmeridae based on mitochondrial DNA (mtDNA) analysis. In addition, the family Sundasalangidae originally established by Roberts (1984) could also be appropriate rearrangement from the order Osmeriformes to the order Clupeiformes based on mtDNA analysis (Ishiguro *et al.*, 2005).

In the age of molecular phylogeny, what kind of strategy is required? A successful strategy needs to involve a taxonomic review, which enables reporting of unrecorded or new species and to establish a database. Then, it is necessary to compile the fish specification according to voucher specimens. A strategy also requires systematic collection, identification and management of specimens including muscle tissues for DNA. Furthermore, the strategy should carry out morphology and molecular studies to understand a phylogenetic relationship or population structure.

STRATEGY FOR MANAGEMENT OF MARINE FISHES IN KOREA

With the implementation of the Convention on Biological Diversity in 1993, each signatory country has been competitively engaged in efforts to securing biological resources for national welfare. In the past, only voucher specimens were conserved using ca. 5% formalin. However, useful genetic information can be gained from muscle or pectoral fin tissues conserved in 100% ethanol. Genetic information is crucial for an understanding of population characteristics such as genetic diversity or migration. The importance and power of the genetic approach will surely increase as its use expands to other tissues. Moreover, the genetic approach will prove instrumental in assessing fish diversity changes influenced by national/international fisheries policies and environmental changes such as global warming.

Korea, China and Japan have recognized the necessity of joint management for the maximum sustainability of fisheries resources. But this resolve is not as easily translated to practice due to national differences in fishing policy and fishery condition. As a start, studies on population structure of common migratory fishes, which comprise *Trichiurus lepturus*, *Scomber japonicus*, *Gadus macrocephalus*, *Pampus argenteus*, *Pampus echinogaster*, *Larimichthys polyactis*, *Larimichthys crocea*, *Pennahia argentata*, *Trachurus japonicas* and *Clupea pallasii* (NFRDI, 2005) is crucial for joint management of fisheries resources.

A molecular study on the population structure of the small yellow croaker, *Larimichtys polyactis* from the Yellow and East China Seas utilizing mtDNA and microsatellite data (Kim *et al.*, in progress) may point the way to a new era of fisheries research. In the past, the small yellow croaker was classified into three populations (Jeolgang, Gangso and Yellow Sea populations Yamada *et al.*, 2007). However, this classification was uncertain. The ongoing study of Kim *et al.* has analyzed DNA variation of the small yellow croaker collected from two offshore regions of both Korea and China, and has already demonstrated that all individuals represent a unique haplotype, with no significant difference evident between the sampling localities. Thus, the small yellow croaker in the East China and Yellow Seas may comprise a single population, which might not have otherwise been evident using less sophisticated approaches. Similarly, in the case of two populations of Mediterranean *Thunnus thynnus* having different spawning grounds, no difference was evident in mtDNA and microsatellite structure (Carlsson *et al.*, 2004).

On the contrary, there may be genetic difference between regional populations. In the case of *Ammodytes personatus*, the East Sea population is clearly distinguished from the West and South Sea populations in mtDNA sequence (Kim *et al.*, 2006) and morphology (Kim *et al.*, 2008). This may in part reflect the influence of the cold current ecosystem formed in the north part of polar front in the East Sea.

During the past 40 years, the surface water temperature in the coastal waters of the Korean Peninsula has increased by 0.8°C in the East Sea, 0.97°C in the West Sea and 1.04°C in the South Sea (NFRDI, 2008). Each fish species has a preferred water temperature range for its own habitat. Therefore, a change in water temperature may cause expansion or reduction of species distribution. Over a longer-term, this could cause regional extinction of some species. For instance, although both *Theragra chalcogramma* and *Gadus macrocephalus* prefer cold water, the difference of catch between the two species is gradually increasing, perhaps due to the difference of their response in hatch success to bottom water temperature (Jung *et al.*, 2008).

The predicted sea level increase caused by global warming could eliminate tidal flats of the West coast of Korea. This would surely lead to the extinction of various species that are dependent on this habitat. Compliance with the Kyoto Protocol would be a prudent course to help minimize such coastal change in Korea and elsewhere. In addition, establishment of a dedicated climate change research and monitoring facility on Jeju Island would be valuable in monitoring marine ecosystem change around the Korean Peninsula. Based on species' distribution limitation by factors such as water temperature, monitoring efforts may benefit from species classification ranked in terms of endangered species (e.g., *Theragra chalcogramma*), threatened species (e.g., *Larimichthys crocea*), monitored species (e.g., *Larimichthys polyactis*) and interesting species (e.g., *Thunnus thynnus*).

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한국 해산어류의 종다양성 및 보전

김진구

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요 약 : 한반도 주변 3개 해역은 서로 다른 지형과 다양한 해류의 교차로 종다양성의 근간이 된다. 또한, 복잡한 해류가 만나는 전선 주변으로는 좋은 어장이 형성된다. 그러나, 남획에 의한 자원의 감소 및 EEZ 발효에 의한 어장의 축소는 새로운 수산자원 관리법을 필요로 하게 되었다. 수산자원의 효율적 관리를 위해 우선 다양한 해양환경에 적응한 지역개체군의 실체를 파악하는 것이 필요하다. 지역개체군의 형태 및 유전에 관한 연구는 자원의 관리단위 및 구역을 명확히 하는 데 기여할 것이다. 최종적으로 해역별 수산자원의 관리방안 제시가 가능할 것으로 기대된다.

찾아보기 낱말 : 한국, 해산어류, 종다양성, 유전적 다양성, 종보전, 관리단위