THE JOURNAL OF
WORLD INTELLECTUAL PROPERTY

The Journal of World Intellectual Property (2015) Vol. 18, no. 1–2, pp. 41–64
doi: 10.1111/jwip.12030

Intellectual Property Rights Access to Genetic Resources and Indian Shrimp Aquaculture: Evolving Policy Responses to Globalization

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Globalization of the aquaculture industry raises important questions regarding the means to ensure a balance between intellectual property rights (IPRs) and access to resources. Advocates of IPRs endorse convergence towards implementing Trade-Related Aspects of Intellectual Property (TRIPs) agreement as a method for promoting innovation, while others support divergence from global standards in order to uphold access to resources. This study analyzes the impact of the convergence–divergence debate on IPRs and access to resources in India's shrimp aquaculture sector. The Indian shrimp sector is at a crucial juncture, moving towards greater globalization and integration with international markets, along with the introduction of new species, new technologies and an increasing role for foreign companies. India requires access to foreign-improved breeding material and technology, but must also create incentives for companies and institutions to invest in genetic material. In response to globalization, India's policy demonstrates both convergence and divergence with global standards. This paper outlines the policy options for India and points out that India's policy choices need not be restricted to one model, but can be based on innovative strategies to ensure a balance between IPRs and access over aquatic resources.

Keywords Intellectual Property Rights (IPRs); access to resources; shrimp; aquaculture; globalization; convergence; transvergence; India

Introduction

Globalization of the aquaculture industry is occurring worldwide through greater privatization and commercialization of aquatic resources, the application of modern biotechnology to aquaculture and the expansion of legal and biological methods to protect aquatic material. Globalization can be defined as the integration of economies, industries, markets, cultures and policymaking around the world.[1] A key feature of the aquaculture industry today is a greater focus on global markets. Aquaculture is one of the fastest growing industries in the world, and approximately 50% of the total world fish harvest is internationally traded (Garcia and Grainger, 2005). As compared to 9% for meat products, 37% of world aquatic production is traded internationally (Gura, 2009). Some experts predict an increase in future aquaculture trade, with India, Latin America and Africa becoming significant exporters of aquaculture products during the next two decades (Garcia and Grainger, 2005). Food and Agriculture Organization (FAO) notes an increasing globalization of the fisheries value chain, in which processing is being outsourced to Asia (e.g. China, Thailand and Vietnam) and, to a lesser degree, Central and Eastern Europe (e.g. Poland and Baltic countries) and North Africa (Morocco) (Gura, 2009). Mergers and acquisitions within the aquaculture industry are increasing and the market penetration of aquaculture genetics companies in the North is already very high (around 70% in salmon and trout seed) (Gura, 2009).

Hailed as ushering in 'blue revolution', aquaculture's promise is that, within the next three decades, it could produce most of the world's marine produce, help to alleviate poverty and food shortages in some of the world's poorest countries[2]. Mirroring developments in the green revolution, the blue revolution has seen companies breeding fish to improve traits, such as their growth rate, conversion of feed into flesh,

resistance to disease, tolerance of cold and poor water and fertility.[3] As genetic engineering and genomics facilitate more patentable innovations, patents and other forms of intellectual property rights (IPRs) are likely to become more attractive to the aquaculture industry. (Olesen et al., 2007).

The globalization of the aquaculture industry raises important questions regarding rights and access over genetic resources. Internationalization would lead to greater demands for IPRs and biological protection of innovations and improvement of genetic material. Breeding companies would seek to ensure economic returns on their investments, particularly as they expand into overseas markets. Simultaneously, breeders and farmers would face pressures to gain affordable access to improved genetic material and technology. Therefore, achieving the right balance between access and protection would be an important goal for national governments.

India is an interesting case study as its shrimp industry is currently undergoing a process of greater globalization. A greater shift to the global stage is evident in India's shrimp sector, with the introduction of new species, new technologies and an increasing role for foreign companies. India has also played an active role in international negotiations dealing with access to genetic resources and IPRs, and is among the first developing countries to have established laws on biodiversity and access and benefit sharing (ABS) pertaining to genetic resources. India is rich in aquatic biodiversity, has a vast coastline and has possibly one of the richest multi-species fisheries areas in the world (James, 2000).

The impact of globalization has led to a debate about whether nations and domestic actors are converging towards a single model (convergence) or are exhibiting diversity in their responses (divergence). Those who stress convergence claim globalization compels countries, industries and firms to converge towards a single, most efficient or adaptive, pattern (Guillen, 2000). Others point to divergence, noting that actors strive to be different, namely, to leverage their unique economic, political and social advantages in the global marketplace (Guillen, 2000). Applying the convergence–divergence debate to the study of India's shrimp sector, this paper raises the following questions: (1) Does India's policy response to globalization in the shrimp sector differ from or follow global standards? 2) What are the likely implications for access to resources of such convergence/divergence in India's policy? 3) What are the policy options for India for ensuring access to resources for farmers and breeders, while simultaneously promoting investment and innovation in the shrimp sector? The paper is structured as follows: The first section describes the theoretical framework of the convergence–divergence debate. The second part outlines the evolving global standards and policies in the aquaculture sector and compares India's policies with these global standards. Implications for access to resources are analyzed in the third section. The final part evaluates the policy options available to India, utilizing business models of crossvergence and transvergence.

Globalization and Convergence–Divergence

A current debate with regard to globalization focuses on how domestic actors respond to greater internationalization. The theories of convergence and divergence address this question from different viewpoints. Convergence points out that countries and organizations respond to globalization by moving towards a universal model of economic success (Guillen, 2000). Divergence scholars point out that globalization is not about convergence to best practice, but rather about leveraging difference in an increasingly borderless world to gain differentiated positions and advantages (Guillen, 2000).

Convergence denotes a process wherein distinctive domestic institutions and economic policies are replaced by common economic structures that are considered more efficient (Cao, 2006). Convergence scholars assert that as the countries liberalize their markets, develop institutions and adopt modern technology, nations and organizations would gravitate towards a supposedly universal model of economic success in order to cope with globalization (Gupta and Wang, 2004; Guillen, 2000). They subscribe to the

view that a given technology will shape both educational demands and business structures such that they will generate values that are 'common' to the given technology.[4] Divergence, on the other hand, refers to persistent and maybe increasing diversity of national policies and institutions (Cao, 2006). Advocates of divergence argue that sociocultural influence is the driving force that will cause individuals from a society to retain the specific values system of the societal culture through time, regardless of other possible influences, such as technological, economic and political change.[5]

The harmonization of IPR laws through TRIPs of the WTO (World Trade Organization), and the resulting implementation of TRIPs within countries can be seen as a process of convergence. On the other hand, the attempts to resist TRIPs and evolve differing mechanisms to protect genetic resources, farmer's rights and traditional knowledge can be viewed as divergence. Convergence and divergence can emerge simultaneously, both as a process and an outcome category (Hay, 2004 in Wijk and Ramanna, 2007). Wijk and Ramanna's (2007) analysis of intellectual property in Indian seed markets clearly reveals that both convergence and divergence can occur at the same time. They point out that when systems are implemented due to external pressure, convergence doesn't occur without some amount of divergence (Wijk and Ramanna, 2007). Focusing on India as a case study, this paper analyzes the convergence–divergence debate in relation to IPRs and access to resources in aquaculture. It examines the factors leading to convergence/divergence in India's shrimp sector, pointing out the policy options that can be pursued to ensure a balance between IPRs and access to resources.

Globalization and Shrimp Aquaculture in India

The shrimp aquaculture sector in India, being largely export oriented, has always been shaped by international factors. Shrimps constitute a major sector of India's marine exports. The export value of frozen shrimp in the year 2010–2011 was $1261.83 (US million) up from $883.03 (US million in the year 2009–2010.[6] Frozen Shrimp, as in earlier years, continued to be the major export value item for India accounting for 44.17% of the total of marine product export earnings (in US $) in the year 2010–2011.[7] India exports frozen shrimp to 62 countries with the major markets being United States, European Union and Japan.[8] In view of the high potential of shrimp farming to contribute to the Indian economy, it is one of the priority sectors for the Government (Ravichandran and Ponniah, unpublished draft, 2010). Shrimp production in India reached a total of 95,918.89 million tonnes in 2009–2010 and area under cultivation was 1,02,259.98 hectares.[9] There are a total of 351 hatcheries producing shrimp and prawn seed in India, out of which 280 hatcheries were dedicated to shrimps with a total annual capacity of producing 12.5 billion post larvae (Ravichandran and Ponniah, unpublished draft, 2010). The shrimp industry in India has seen great fluctuations[10] ranging from high growth and profits to significant loss of market share and revenue (Ravichandran and Ponniah, unpublished draft 2010; Ramanna-Pathak, 2012).

Recently, some policy changes have led to a greater globalization of the Indian shrimp sector. The major shift has been from an industry focused on a native species of shrimp towards exotic foreign species and pathogen-free shrimp. Shrimp farming in India has historically been one of monoculture, producing mainly black tiger shrimp, *Penaeus mondon,* a species native to India. The major problem facing shrimp aquaculture both in India and worldwide is disease outbreaks. In 1995, the Indian shrimp industry was plagued with the White Spot Syndrome Virus (WSSV), which was devastating for the industry and its repeated occurrence demoralized the shrimp farmers (Yadava, 2002). WSSV is probably the most striking example of spread of disease and consequential major economic loss in aquaculture. Annual economic losses from the impact of the disease have been estimated to be in the range of more than US $400 million in China (1993), US $17.6 million in India (1994) and over US $500 million in Thailand (1996).[11] The economic losses suffered by the Indian shrimp industry due to disease, as well as the competition internationally, led to the demand for the introduction of disease-free

shrimp. India had to acquire such resources from abroad, and this paved the way for the entry of global private firms in Indian aquaculture.

Evolution of Standards and Policies in Aquaculture

Global standards and policies in aquaculture relating to IPRs and access to resources are in a nascent stage. Processes emerging globally reflect conflicts over balancing different objectives, including rights over genetic resources, equitable sharing of benefits and IPRs to promote innovation. India's policy framework also embodies the tensions between these goals, as well as the embryonic nature of international developments. In order to outline global models in comparison with India's policy, we focus on three main factors that have been identified as being important for actor perceptions with regard to access to resources in aquaculture (Rosendal et al., 2006; Olesen et al., 2007): (1) *Legal standards*, which include international agreements and regimes dealing with IPR and access to genetic resources. The important agreements analyzed here are TRIPs of the WTO, the Convention on Biological Diversity (1992) (CBD) and the Nagoya Protocol (NP). (2) *Biological protection* explores the ways in which companies utilize biological methods to protect innovations related to aquaculture and (3) *Structural factors* describe the various forms of ownership and the trends towards privatization. Two main structural factors are identified here are shifts from public to greater private control over aquatic breeding material and policies to cope with disease in shrimp, particularly the move towards exotic species and attempts to develop disease resistance.

Legal Standards: Intellectual Property Rights and Access to Resources

IPRs are limited property rights over information resources. IPRs are currently subject to national legislation, but the TRIPs concluded in 1995, paves the way for global standards in intellectual property. TRIPs of the WTO led to a wider application of IPRs to animals and plants and greater extension of IPRs to agriculture and allied fields. IPRs, such as patents, have not been utilized extensively in aquaculture, but this situation is likely to change with greater technological progress and increasing need for legal control over aquatic resources. According to the FAO, "*Although the TRIPs Agreement so far has had only limited implications for trade in fishery products, the importance of TRIPs is expected to increase in line with the projected growth in aquaculture and the possible use of biotechnologies in production.*"[12]

Patents are a form of IPRs that provide strong protection for industrial innovations. TRIPs stipulates that patents should be granted to any invention, whether product or process, in all fields of technology. Patents can be granted on a product or processes relating to biological material, gene sequences, major genes affecting important traits or a genetic marker, but an unresolved question in practice, as well as in patent theory, is what a patent on a naturally occurring gene covers (Tvedt, 2007). Patents are currently available in many countries for fish breeding, but there are only a few examples of patents in this sector including: genetic disease resistance marker in salmon, transgenic salmon, patent on determination of viral disease resistance of salmon and triploid oysters (Olesen et al., 2007). A scan of Norwegian fish patents by Olesen in 2007 revealed three patents, one involved a genetic marker for disease resistance and two on transgenic fish (Olesen et al., 2007). One of the reasons that patents have probably not been used extensively in aquaculture is the difficulty in fulfilling patent criteria (Olesen et al., 2008). With greater knowledge about the genome of fish species, this difficulty could be overcome and we could see greater use of patents relating to aquatic resources (Olesen et al., 2008). Patenting of new fish varieties and of processes can be expected to increase significantly as the aquaculture industry expands, according to Greer and Harvey (2004). The US Patent Office has already approved a patent for a method for increasing the growth rate of transgenic salmon (Greer and Harvey, 2004). The most common case for process patents in fish breeding could arise from combining pure biological processes, such as selection and crossbreeding, with a very low level of technological, nonbiological knowledge (Rosendal et al., 2005). The potential of

aquatic resources remains largely unexplored and therefore, once tapped, may increase the likelihood of patenting of living aquatic resources or parts thereof, including genetic material (Ninan et al., 2004). Tvedt (2007) in his study of patent protection in aquaculture in Norway and the European Patent Office, points out that patent applications relevant for aquaculture and the fish breeding industry are increasing. However, he notes that several issues, particularly those related to the extent of patent protection in aquaculture, are still left to practice and case law development (Tvedt, 2007). Patents in the aquaculture sector are increasing but so far have mainly targeted methods for breeding/improvement or patents to pathogens to the production animals, such as in the Norwegian Pancreas Disease case cited by Tvedt (2013).[13]

TRIPs stipulates a 'sui generis' system for plants and animals. Some authors have also pointed out that there may be a need for a similar sui generis system for aquaculture. Sui generis refers to a special IPRs system adapted to the needs of a specific sector. Greer and Harvey (2004) point out that mechanisms equivalent to the sui generis system for plants and animals for aquatic genetic resources are likely to develop with modifications that reflect the fact that few aquatic animals have been domesticated. This sui generis system for plants and animals emerged as a result of enormous opposition to extending patents to plants and animals. TRIPs ultimately concluded that plants and animals need not be patented, but must be protected under a form of IPRs referred to as "sui generis".[14] What constitutes 'an effective *sui generis* system' is not defined by WTO and has led to enormous debates internationally (Grain, 2011). In trying to standardize the clause 'effective sui generis', the push has been to grant protection based upon plant breeders' rights. Plant Breeder's Rights (PBRs) are patent-like rights that allow the plant variety owner to prohibit specific unauthorized uses of the variety.[15] PBRs systems are distinct from patents in allowing farmers to save seed for subsequent seasons.[16] There are international processes now considering the possibility of establishing animal breeder's right similar to plant breeder's rights (Rosendal et al., 2005). However, 'breeder's rights' are not applicable to fish due to the need for much higher genetic heterogeneity in most commercial fish populations (Rosendal et al., 2006; Olesen et al., 2007). According to Rosendal et al. (2005), as most fish breeding systems are unsuited to meeting the criteria of PBRs of being new, distinct, uniform and stable, there may be a need to design a sui generis system for aquaculture breeds.

Access to genetic resources is significant area of contention in TRIPs relevant for aquaculture. The Convention on Biological Diversity (CBD) signed at the Earth Summit in Rio de Janeiro in 1992 was utilized by developing countries as a means of countering some aspects of the TRIPs agreement, which these countries, including India, vehemently opposed. Although TRIPs and the CBD developed in parallel, both of the agreements took years to negotiate. This enabled the developing countries to promote the CBD as a counter to TRIPs. Developing countries argued that an inherent inequality existed within TRIPs: industrial innovations were protected through IPRs, but genetic resources were considered 'common heritage' and were freely available. They asserted that TRIPs promotes 'biopiracy' or the unauthorised, commercial use of genetic resources and publicized examples of patents based on biological resources (Wijk and Ramanna, 2007). Biopiracy also has relevance in the aquaculture sector as resources accessed from one country could be utilized in another without adequate compensation. Moana Marine Biotech Inc., Hawaii, collected wild brood stock for its Specific Pathogen-Free (SPF) *Penaeus monodon* programme from various areas, including Asia. Nile Tilapia originates in Africa, but the utilization of this fish is primarily in Asia. Although it would not be correct to term these instances as biopiracy, particularly in the case of Tilapia where the attempt has been made to promote it as a public good, it is clear that there can be scope for biopiracy in the field of aquaculture as well. A clear North–South divide emerged on this issue as the North currently has a predominant position in terms of technology and resources to file and enforce patents, but the South houses the greatest store of biodiversity. Industrialized countries require access to genetic resources, and developing countries need access to technology. To ensure compensation for utilizing genetic resources and to legally assert rights over their biological resources, developing countries

drafted new standards under the CBD (Rosendal et al., 2013). Genetic resources were no longer 'common heritage', and the CBD reaffirmed the sovereign right of nations over these resources. This move was initiated by the third International Undertaking resolution by the Commission on Genetic Resources for Food and Agriculture (CGRFA). The CBD promoted ABS and prior informed consent as mechanisms to protect genetic resources. ABS prescribes that actors accessing biological resources should pay compensation for utilizing the resources. However, implementing ABS and prior informed consent have been controversial issues, and are still subject to intense international debate.

The NP was adopted in 2010 as a legally binding supplementary agreement to the CDB. It entered into force at the Conference of Parties 12 held under the CBD in October 2014. "Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits arising from their Utilization" was concluded at the 10th Conference of Parties to the CBD in Nagoya. It aims to further develop the legal ABS framework provided by the CBD. According to the Union for Ethical Biotrade (2010), the NP provides a more expansive interpretation of the scope of ABS through the definition of 'utilization of genetic resources'. Some countries have asserted that under the NP, the definition clearly covers research and development linked to the biochemical composition of plants and other components of biodiversity and also includes 'derivatives' of genetic resources that refer to biochemical compounds (Union for Ethical Biotrade, 2010). However, this issue continues to be a point of debate within the CBD. Industry interests state that derivatives should not be part of the definition of genetic resources as "It is not possible to identify in practice, whether such substance is resulting from the genetic expression or metabolism of genetic resources" (International Chambers of Commerce, 2013). The NP itself does not provide a list of specific uses of genetic resources that would be covered (Greiber et al., 2012). The NP stipulates that user countries undertake to ensure that access to genetic resources take place with prior informed consent (Tvedt and Fauchald, 2011). The setting up of 'checkpoints' and 'internationally recognized certificates of compliance' are also envisaged under the NP as a means of ensuring transparency. The NP also states that the use of genetic resources should take place with the prior informed consent of indigenous and local communities, in cases where they have the right to grant access to such resources (Union for Ethical Biotrade, 2010). Article 10 of the NP refers to a global multilateral benefit sharing mechanism. According to the NP, "Parties shall consider the need for and modalities of a global multilateral benefit sharing mechanism to address the fair and equitable sharing of benefits derived from the utilization of genetic resources and traditional knowledge associated with genetic resources that occur in transboundary situations or for which it is not possible to grant or obtain prior informed consent."

The NP does promote clearer standards for implementing ABS, but the issues around access and benefit sharing are not completely resolved. The CBD and the NP establish private contract law as a means for establishing rights over genetic resources (Tvedt, 2013). According to Tvedt (2014), a number of legal and technical challenges arise with access and benefit sharing contracts, such as how to regulate the subject matter being transferred. Kamau et al (2010) (p. 257) state that, "As before the enforcement of benefit-sharing duties is left to contractual means, with all the difficulties of forum, litigation costs, and prosecution of titles." According to Tvedt (2013), "Contracts generally suffer from a lack of a clear trigger point for benefit sharing once a commercial product has been developed, a situation that is complicated by whether to aim governance at the point of access or the point of utilization of GR. This problem is enhanced by the lack of a functional monitoring / tracing mechanism, along the lines of the providers' failed attempt at linking ABS to the much stronger IPR systems through disclosure." The NP does outline the need to develop model contracts and sectoral model contracts can be negotiated to serve special purposes (Tvedt, 2013). Perhaps this provision could be utilized to devote specific attention to the needs of the aquaculture sector.

In addition to the TRIPs and CBD, the discussions within the FAO are important for understanding the debate around access and benefit sharing. From the beginning of the negotiations on genetic resources,

there was contention regarding the demarcation between the CBD and the FAO on common heritage and patents in relation to seeds. The CBD responded by aiming to balance increased Northern patents with sovereign rights over genetic resources. For *ex-situ* collections of seeds in international gene banks, collected prior to the CBD entered into force, the dispute between the FAO and the CBD resulted in the provision that pointed out the role of FAO in addressing this particular *ex-situ* material (Andersen, 2008; Rosendal, 2000). In 2001, the FAO Parties concluded the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) on this basis and after long political struggles ended up with coverage of 35 food plants and 29 forage plants. This is referred to as the Multilateral System of the ITPGRFA.

The CGRFA under the UN FAO is currently focusing on questions related to access and benefit sharing for six groups of genetic resources: animals; aquatic; invertebrates; plants; forest and microbial genetic resources. Shortly after the conclusion of the NP, the CGRFA began preparations for negotiations on sectoral approaches in these areas. The negotiations also included plants outside the scope of the Multilateral System (MLS) of the ITPGRFA. While sectoral approaches may enable focus on the unique aspects of specific areas, this could take certain resources out of the ABS under the Protocol it might be difficult to maintain the balance in the CBD between access and benefit sharing (Tvedt, 2014; Medaglia et al., 2013). There has been some debate among parties to the Commission regarding the extent to which new regime for ABS for these genetic resources are needed (Tvedt, 2014). The mandate at this point is not to negotiate specialized regimes but to explore the questions on needs for these sectors (Tvedt, 2014). But as Tvedt (2014) points out, any agreement in the Commission could potentially exclude commercially valuable groups of ABS governed by the CBD and the NP.

The entire debate regarding ABS in various forums is mainly seen a North–South issue, but it is not quite the same in aquaculture. According to Greer and Harvey (2004), the controversy over IPRs and genetic resources is a North–South issue in agriculture and pharmaceuticals, but it is not the same in aquaculture. Aquatic genetic resources exist both in developed as well as developing countries, whereas most agricultural genetic resources are found in the South. Fish are most successfully bred in conditions that most closely approximate their original habits and various temperate regions have their share of potentially useful aquatic biodiversity (Greer and Harvey, 2004). The exchange of agricultural genetic resources has mostly been from South to North, but the flow of resources is not unidirectional in aquaculture. Exchange of aquatic resources have taken place between developing countries, as in the cases of tilapia and catfish. Exchanges have also been within Northern countries, as well as from North to South, particularly in the case of Salmon (Bartley and Benzie, 2009; Rosendal et al., 2013). The FAO notes that the "*exchange of aquatic genetic resources has generally not been from South to North as appears to have been the case in the crop sector*" (Bartley and Benzie, 2009). This could provide a part of the explanation for the fact that in contrast to seeds and agriculture, there have been few cases of ABS issues arising in the aquaculture (Rosendal et al., 2013). According to the FAO, "*concern for compensation for providing aquatic genetic resources used in other countries has not yet been widely expressed*". (Bartley and Benzie, 2009). Yet this has undergone a change with genetic resources in shrimp and fish now form part of the general claim under the CBD and the NP.[17] Another part of the explanation for the few cases of ABS issues in aquaculture may be the much lower incidents of traditional knowledge in aquaculture compared to agriculture and medicine; there are few 'farmers' breeds' or landraces of fish, as the major bulk of the worlds' fish farming is based on wild catches (Rosendal et al., 2013). However, with the further exploration of aquatic biological resources and the greater internationalization of the aquaculture sector, conflicts related to access and benefit sharing of aquatic resources are likely to emerge. In contrast to the North–South divide in agriculture, such issues are further complicated in the case of aquaculture as disputes could also arise between developing nations themselves.

4.1.1 India's Policy on IPRs and Access to Resources

India joined the WTO and was therefore obliged to implement TRIPs. India was one of the most vocal opponents against, including IPRs, in the WTO and resisted pressures to raise its standard of IPRs. Ultimately, however, external bilateral and multilateral pressure, along with changes within India, led India to ultimately join the TRIPs Agreement and amend its patent laws (Ramanna, 2005). India's opposition to TRIPs focused on the extension of product patents in agriculture and pharmaceuticals, granting of patents to plants and animals and protection of genetic resources. India's patent law of 1970 restricted the field of patentability; granted process and not product patents in food, pharmaceutical and chemical fields and restricted the term of patents. Plant varieties that were used by farmers were viewed as an open source, and the Patent Law 1970 largely excluded agriculture from protection.[18]

India amended its Patent Act 1970 to comply with TRIPs through the Patent Amendment Acts 1999, 2002 and 2005. Essentially, these amendments paved the way for product patents in pharmaceuticals and agrochemicals. India also established breeder's rights in India to comply with TRIPs. India's compliance with TRIPs proceeded simultaneously with the setting up of laws to promote farmer's rights and protect genetic resources. India is among the first countries in the world to have passed legislation granting Farmers' Rights in the form of the Protection of Plant Varieties and Farmers' Rights Act 2001 (PPVFR). India's law is unique in that it simultaneously aims to protect both breeders and farmers. India has also passed the Geographical Indications of Goods (Registration and Protection) Act 1999 to provide protection for goods (including agricultural goods) that originate in a specific territory or region. According to Kochar (2008), there are ample opportunities to identify geographically linked process and products in aquaculture for facilitating their registration and protection as geographical indications, and ultimately extending the benefits to farmers/fishermen. Under this Act, there is a separate classification for fish, but there have not yet been any registrations in this category. The possibility of protecting India's indigenous shrimp under the Act cannot be ruled out. India's Patent act also requires disclosure on patent applications of any use of genetic material, a provision not found in patent laws of most developed countries.

India's National Biodiversity Act 2002, enacted to implement the CBD, regulates access and use of genetic resources in India. Prior to this law, India considered such resources as common heritage and no regulatory authority existed to check such access or use. With the establishment of the National Biodiversity Authority (NBA), foreign nationals must now seek permission before accessing any biological resource in India. The NBA also regulates IPRs on biological resources by requiring anyone applying for a patent on a biological resource to first get the permission of the NBA to access the resources. Indian nationals can access biological resources, but they must comply with benefit sharing, which applies to both citizens and non-citizens of India. Benefit sharing, which essentially entails compensation for use of genetic resources, is to be done on mutually agreed terms. The NBA states that it would provide guidelines regarding benefit sharing on a case-by-case basis.

The lack of clarity regarding scope of patent protection over plants and animals resonates in India. TRIPs and India's Patent Law state that microorganisms are patentable (Senan et al., 2011). According to Senan et al. (2011), India's Patent Act doesn't provide a definition of the term ‘microorganism’, leading to debates regarding patentability of microbes. India's Act doesn't allow patenting of plants and animals per se, essentially biological processes for the production of plants and animals and the method of treatment of humans and animals. In addition, transgenic plants and animals, gene sequences of plants or animals and Expressed Sequence tags are not patentable (Bala Ravi, 2006).

Biological Protection and Technological Developments

The fluid state of IPRs, the biological characteristics of fish breeding that restrict scope for patentability, and the nature of ownership largely shaped by the public sector have led the aquaculture industry to employ

biological rather than purely legal protection measures. The most widely utilized strategy in aquaculture appears to be a combination of legal and biological protection. Rosendal et al. (2006) and Olesen et al. (2007) in their study, found that, "The aquaculture industry has preferred continuous upgrading of the material through genetic improvement combined with contracts (between breeding company and multiplier) to protect its material. This enables companies to maintain competitive power and hence make the customers come back regularly for new purchases". The most common biological protection strategy in aquaculture breeding programs is continuous upgrading of the material (Rosendal et al., 2005). Technological developments have enabled the aquaculture industry to protect their materials through techniques such as: DNA markers to trace and enforce rights, reproductive sterility, triplodisation techniques and methods to control and document the origin of brood stock (Rosendal et al., 2006; Gura, 2009). DNA markers can be used to differentiate between different cultured stocks or between wild and cultured stocks (Gura, 2009). The genetics industry is looking for a possibility to control and document the origin of brood stock (Gura, 2009). Allele frequencies, marker genes and DNA fingerprinting are gene technology and biochemical methods together with databases that have already been applied for such tracing or pedigree control (Gura, 2009). In several aquaculture species, applicable methods based on polyploidy are available for commercial-scale propagation of sterile production animals (Pepper, 1991; Sutterlin and Collier, 1991 in Olesen et al., 2008). These are routinely used in some production systems today (Bonnet et al., 1999 in Olesen et al., 2008) to avoid problems with sexual maturation and spawning. The shrimp genetic industry has developed reproductively sterile, all-female shrimp for commercial culture. The Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) have been optimizing triploidization technologies developed in the shrimp variety *Penaeus japonicus* to be suitable for commercial-scale triploidy in the two regionally more active important varieties Black tiger prawn *P. monodon* and Pacific White shrimp *Litopenaeus vannamei* (Gura, 2009). However, the above-stated activities are in various stages of experimentation and may not accessible at this point.

Hein van der Steen, a shrimp breeder, advocates that the shrimp breeding industry must rely on 'rings of protection' as long as the ultimate protection, that is high-quality sterile Post larvae (PL), is not in place (quoted in Gura, 2009). PLs refer to the stages in the growth of shrimp. Farmers use the term PL to refer to various stages denoting them as PL1, PL2, etc. The 'protection rings' that can be used by companies globally include:

- Contracts designed to prevent the use of PLs for the production of brood stock and subsequent breeding
- Traceability that enables tracing shrimp back to previous generation Cross between inbred lines, which results in offspring less suitable for further breeding (less heterosis in subsequent generations)
- Selling a narrow genetic base, which also results in offspring less suitable for breeding
- Biological upgrading that ensures the customers return to the company to buy their products

These biological and technical means of protection at present are preferred to patents by the aquaculture industry as the knowledge can be kept secret and avoids legal battles. Gura (2009) points out that the "the aquaculture genetics industry is not at the spearhead of those pushing for animal patents. Broad patents may be an argument to attract shareholders. But patents are valid for a limited time of 20 years, costly to defend in case of infringements, and the knowledge is published. Technical ways to prevent others from breeding are more durable, and the knowledge may be kept as trade secret." Selling brood stock with increasing levels of inbreeding is another method to protect the company's interests that is practiced among shrimp breeders. According to Gura (2009), "Shrimp breeders are recommended to sell brood stock that will accumulate ever-increasing levels of inbreeding in successive generations as a

biological mechanism for property protection of shrimp breeding stock. Pirated shrimps will have a very low reproduction rate or even die".

One of the most relied upon protection methods for genetically improved populations for fish has been to register product names and trademarks (Rosendal et al., 2005). Rosendal et al. (2005) in an interview of aquaculture industry representatives in Norway found that branding was the protection method to be considered the most relevant currently. Strictly, this will not protect the genetic material from being propagated and used by outsiders, but only prevent unauthorized use of the registered name (Rosendal et al., 2005). According to Rosendal et al. (2005), "branding can be combined with additional measures such as biological protection strategies like continuous upgrading or crossbreeding of the material, or with high quality management of the seed production process, good customer support and services, and high profile information and marketing strategies."

Another legal mechanism, which is used in combination with biological protection, is material transfer agreements (MTAs). MTAs are private legal contracts between seller and buyer that have traditionally been the most common means for regulating trade and transfer of livestock (Olesen et al., 2008). Under these contracts, the breeding programme supplies the user with genetically improved brood stock or seeds, often via a multiplier, with conditions such as financial returns to the breeding program and limitations on the use of the material (Olesen et al., 2008). However, according to a survey by Rosendal et al. (2005), some companies using MTAs report problems with control, enforcement and monitoring of the terms of the agreements with the multipliers. Difficulties include tracing and verifying the number and origin of marketed seed, as well as regulating the activities of third parties who are not legally part of the contract (Rosendal et al., 2005). Rosendal et al. (2005) point out that to secure investments in breeding, this approach must be combined with strong rules on restricting further distribution of the material and improved tracing opportunities.

Biological and Legal Protection in India

Biological protection strategies with regard to shrimp aquaculture were not prevalent until recently in India as most of the material was sourced from the wild and based on indigenous species. Innovations and improvement in material were mainly initiated by the public sector, which had the normative goal of widely distributing material rather than protecting it with biological methods. Biological protection strategies are now coming into play in India with the introduction of exotic species and the greater scope for foreign companies to invest in India.

International firms now investing in India are relying on a combination of biological and legal protection rather than IPRs to protect their materials. This is the same strategy used by aquaculture companies globally, and is in tune with the global trends. Companies supplying vannamei to India are using legal contracts and biological protection methods, such as selling a narrow genetic base, cross between inbred lines and continuous improvement to protect their material. The contracts between Indian and foreign companies on imports of the exotic species vannamei are negotiated mainly on price and not IPRs. According to one source from a global firm based in Indonesia producing vannamei, "When we sell, we give very limited family." He further elaborated that, "…it is a difficult strategy to keep people from taking your technology. It is better to improve your product so that people will keep coming back to you and your product will be better. We deal with the farmer so it is difficult to enforce IPRs. It is worse if we patent because then the information is open but at the same time we can't protect the technology". Moana Biotech, the sole supplier of SPF monodon in India, keeps its production technology secret to restrict transfer of technology and material. SPF and SPR (Specific Pathogen Resistant) are terms that refer to efforts to cope with disease.[19] Moana does not transfer brood stock but only PL to its own multiplication centre in India. Moana Marine Biotech is also utilizing protection strategies, such as contracts and traceability.

Structural Factors

Public–Private Shifts

Public–private relations in the aquaculture sector are undergoing changes similar to agriculture where there is a movement towards greater privatization of public resources. Two cases illustrate the ways in which aquaculture programmes initiated by the public sector can be acquired by private actors. The case of salmon in Norway, analyzed by Rosendal et al. (2013), demonstrates that changes in ownership can occur quite rapidly resulting in a transfer of public resources into the private domain. Salmon breeding programmes in Norway were initiated with public financing in 1971 by a non-profit research institute and the base populations for these programmes were collected from Norwegian rivers (Rosendal et al., 2013; Gjøen and Bentsen, 1997). In the late 80s, these breeding populations were transferred to a cooperative of farmer organizations. As the farmer's organization went bankrupt, a shareholder company took over the ownership of the salmon breeding programme in 1992. Further changes in ownership occurred ultimately resulting in Norway's Aqua Gen AS, the world's largest salmon breeding company, becoming the primary owner of this material (Olesen et al., 2008). The acquisition of majority shares (50.2%) in Aqua Gen by Germany's EW group means that Norway has gradually lost control over the originally public breeding programme for salmon (Olesen et al., 2008; Rosendal et al., 2013). Currently, Aqua Gen AS is 100% owned by EW group.[20] This occurred in spite of the fact that mechanisms were established to ensure the public interest by trying to divide ownership between public and private shareholders. The purchase by Germany's EW group was heavily debated within Norway, with concerns being raised about whether the German company will patent the genetic material developed by Norway leading to a situation where Norwegian fish farmers would have to pay high royalties to use the fish material in the future (Olesen et al., 2008). Irrespective of patenting, according to Olesen et al. (2008), Norwegian salmon multipliers and farmers may have to pay higher royalties for roe and seed from the externally controlled Aqua Gen in the future. The case shows that even when domestic public funds are used to develop a national resource (in this case salmon), it can ultimately still come under the control of a foreign private company. It raises the question of how governments can maintain affordable access to publicly funded breeding material (Rosendal et al., 2013). There are two main reasons why public funding may be more beneficial in the early stages of breeding according to Rosendal et al. (2013): firstly, more advanced breeding programmes are often less profitable, particularly on a short term, as they are at least equally costly to start and run as the first generations. Secondly, compared to a private breeding programme that aims at short-term profit, a public or cooperative programme may have a broader range of breeding goals, including animal welfare and environmental concerns (e.g. including disease and parasite resistance). Thus, the main concern of moving towards greater privatization is whether the market would be able to provide high quality breeding programmes even when it may not be profitable initially.

The second example, Tilapia, a freshwater fish indigenous to Africa but introduced in many countries, is probably the most widely debated case of public–private changes in aquaculture. Nile Tilapia presents a unique case where the natural distribution and genetic resources of tilapia is found in Africa, but the utilization of this fish is primarily in Asia (Ambedkar and Hulata, 2009). The Genetic Improvement of Farmed Tilapias (GIFT) was an internationally coordinated project, initiated in 1988 and funded by various institutions and countries for the genetic improvement of tilapia (Ambedkar and Hulata, 2009). It was conceived as a public good, with the objective of ensuring wide dissemination. A highly successful initiate resulted in improved GIFT strains, which were made available to project partners, as well as to a newly established non-profit organization, Gift Foundation International Inc. in 1999 (Ponzoni et al., 2010). This organization ultimately faced financial constraints resulting in the acquisition of the commercial rights to the GIFT strain and representatives from all the latest GIFT families by a Norwegian private company, Genomar ASA (Ponzoni et al., 2010). GenoMar has continued with the breeding

programme and has been very active marketing the fish, and has entered into commercial ventures using their trademark name, GenoMar Supreme Tilapia, in the Philippines, Brazil and China (Ponzoni et al., 2010). Woldfish also owns part of the breeding programme of GIFT and continues to make it available as an international public good (Ponzoni, 2010). Although attempts are being made to ensure access of GIFT in Africa, at present, GIFT breeding material is not available in African countries due to the fears of contamination (Ponzoni, 2010; Rosendal et al., 2013). The GIFT project illustrates that it is difficult to ensure that aquatic resources remain entirely in the public domain, even when it is created with the objective of wide dissemination to poor countries. The global standard with regard to ownership of aquatic resources is moving towards greater private rather than public control.

Public–Private Relations in India

The public sector still remains a driving force within the aquaculture sector in India, but shifts in the normative and structural positions are leading to changes in public–private relations. Greater commercialization and privatization of aquatic resources, taking place both globally and in India, affect the nature of public–private roles. Public institutions in India have played a key role in establishing the domestic aquaculture industry, and investments by the public sector have led to a phenomenal increase in shrimp farm production and the rise of a private sector aquaculture industry in India (Ravichandran and Ponniah unpublished draft, 2010; Ramanna-Pathak 2012). The normative motivation of the Indian public sector historically has been of widely disseminating material rather than creating proprietary products. However, the shifting normative and structural positions within the Indian aquaculture sector would change this scenario, possibly quite rapidly. Private companies can now acquire more aquatic resources from foreign sources, thereby reducing their reliance on public sector institutions. In the future, it may lead to greater demands for protecting rather than widely sharing material (Indian or foreign). In a reversal of roles, the public sector may also become dependent on the private sector (foreign or domestic) for access to materials and technology. Public sector institutions in India, for example, are currently dependent on private sector for access to SPF monodon material and technology. The public sector is also now moving closer towards a position where it would aim to commercialize at least some of its innovations. This could affect issues of access to resources as the public sector may find it difficult to fulfil the mandate of widely disseminating material and protect its inventions. Some analysts criticize the CBD and NP approach to access and benefit sharing as it promotes privatization of biological resources. There are also those who point out that ABS structures reinforce rather than challenge IPR regimes. West, 2012 (p. 22) states that, "the prominence of ABS structures can be attributed to their ability to incorporate traditional knowledge (and protection of genetic resources) into dominant IPR structures without challenging the inherently unequal legal treatment of industrially and traditionally produced knowledge." The CBD/NP framework does attempt to fit ABS within the existing IPR system and this has implications for the public–private relations in India. The public sector has the difficult task of incorporating a greater focus on IPR while still attempting to widely and freely disseminate material.

Policies to Deal with Disease

A structural shift in the shrimp industry has taken place in many Asian countries from indigenous cultured shrimp species to imports of exotic species and the focus on SPF shrimp. One of the main reasons for this has been the problems faced by the shrimp industry worldwide due to the spread of disease. In Asia, first Yellowhead Virus (YHV) from 1992 and later WSSV from 1994 caused continuing direct losses of approximately US $1 billion per year to the native cultured shrimp industry (Briggs et al., 2004). According to the FAO (2011), the introduction of vannamei to Asia from America has resulted in an almost complete shift from the native giant tiger prawn (*P. monodon*) to this introduced species. The shift towards vannamei and the greater focus on acquiring SPF stocks can be viewed as the emerging global policy

model for shrimp. World shrimp farming production using *P. vannamei* expanded from only 10% of total production in 1998 to 75% of total world production in 2006 (Wyban, 2007). Through techniques, such as domestication and genetic selection for favourable traits, such as growth rate, disease resistance and rapid maturation, domesticated stocks of SPF shrimp have been developed and are currently commercially available from the United States (Briggs et al., 2004).

The Pacific white shrimp, *L. vannamei* (formerly *P. vannamei*), is native to the Pacific coast of Mexico and Central and South America as far south as Peru (Briggs, 2004). In the late 1990s, a rapid increase in Asian production levels occurred spurred by the production of the imported *P. vannamei* (Briggs et al., 2004). *P. Vannamei* advantages over *P. monodon* are largely associated with the ability to close the life cycle and produce brood stock within the culture ponds (Briggs et al., 2004). A programme to develop SPF vannamei was started in 1989 in the US Department of Agriculture (USDA)-funded Oceanic Institute in Hawaii, which continues to this day and has been expanded by a number of commercial ventures, mostly located in Hawaii. (Briggs et al., 2004).

Shift Towards Exotic Species and Disease-Resistant Shrimp in India

A major shift in India's policy on shrimp took place in with the introduction of an exotic species of shrimp. India has mainly produced black tiger shrimp *P. mondon*, but recently permitted the import of the exotic species, vannamei. The introduction of vannamei in India occurred under controlled conditions with a clear procedure laid down by the government. Initially, two companies were permitted to conduct trials in a restricted environment.[21] The Central Institute for Brackishwater Aquaculture and the National Bureau for Fish Genetic Resources conducted the risk analysis for the introduction of vannamei in India.[22] Following the risk analysis studies, the government decided for large-scale introduction for commercial use of vannamei in 2009 and the Coastal Aquaculture Authority (CAA) was identified as the body that would grant permission to import vannamei brood stock. (Business Standard, 17 October 17 2008). The Indian Government initiated a unique process not found in other Asian countries by establishing a quarantine specifically for the purpose of importing vannamei.[23] The Government approved international suppliers of vannamei and also determined the Indian companies who could import vannamei.

The decision to permit the production of SPF monodon from Moana Marine Biotech was another measure to cope with the disease plaguing the Indian shrimp industry. Moana Marine Biotech Inc., Hawaii, had initiated a SPF *P. monodon* programme by collecting wild brood stock from various areas, including Asia and South-east Asia. Moana has its headquarters in Hong Kong and through its biosecure facility on the Big Island of Hawaii, the Nucleus Breeding Center and it supplies the parent seed to its overseas Multiplication Centers.[24] Moana Marine Biotech, put forward a proposal for setting up of a Multiplication Centre for SPF *P. monodon* in India in December, 2006.[25] After due approvals, an Agreement in this regard was signed between the National Fisheries Development Board (NFDB) and Moana Technologies in 2008 for establishing a Multiplication Centre.[26] India also has a programme to develop its own SPF monodon programme through the Rajiv Gandhi Centre for Aquaculture (RGCA) under the Marine Products Export Development Authority (MPEDA).[27] With respect of SPF monodon, it is reported that the RGCA is currently working on field trials (Rao, 2010). Central Institute of Brackishwater Aquaculture (CIBA), the nodal agency for the development of brackishwater aquaculture in the country, and one of the main government research institutes in India focusing on shrimp, and has also been working on establishing a breeding programme with monodon (Ramanna-Pathak, 2012; www.ciba.res.in).

The legal, biological and structural factors outlined above point towards a demand for stronger protection of genetic material. Legal standards on patents and ABS with regard to genetic resources are both evolving. However, the patent system is much clearer in terms of protection and appears to be moving ahead at a faster pace. India is also struggling to ensure that benefit sharing mechanisms reach the intended recipients, while the scope and number of patents is steadily increasing. Biological protection in

aquaculture also points to a greater role for technology, which would lead to greater demands by companies to protect resources under IPRs. In India, biological protection is now currently being utilized by aquaculture firms to protect their products. The changes in technology in the global aquaculture scenario would also impact India, leading to greater demands for IPRs in this sector. Structural factors appear to be extremely important both in India and globally in leading to demands for stronger protection of aquatic material. This is particularly so because of greater privatization and moves within the public sector itself towards more commercialization. In ensuring a balance between rights and access, a major concern would therefore be to prevent monopoly situations that could restrict affordable access to aquatic breeding material.

Implications of Convergence and Divergence on IPRs and Access to Resources in India's Shrimp Sector

India requires access to foreign-improved breeding material and technology to prevent and deal with disease outbreaks, as well as to become self-reliant through establishing its own breeding programmes. This is crucial for India to promote the growth of the domestic shrimp industry and to ensure that public sector institutions can conduct research to improve quality and output of shrimp production. Shrimp farmers and breeders also need access to genetic resources for food production and sustainable use of genetic material. The impact of India's convergence and/or divergence from global standards is evident in several dimensions, including the future extension of IPRs to aquaculture, the greater use of biological and legal resources over aquatic material and the shifting nature of public–private relations.

IPRs and Access to Resources

India extended the private–property-based view of information resources to genetic material, farmer's varieties and traditional knowledge. No longer considering them 'common heritage' or freely accessible by all, India declared sovereign rights over these resources, adopting and extending the industrialized nation's view of IPRs to these resources. India also revised the mechanism of geographical indications in order to protect agricultural and other resources in India. This convergence–divergence strategy represents an attempt to balance need for IPRs with ensuring access to resources. It aims to distribute rights equitably, but as analyzed in relation to India's Plant Varieties and Farmer's Rights Act, it may pose the threat of an 'anticommons tragedy', that is too many parties independently possessing the right to exclude others from utilizing a resource (Ramanna and Smale, 2004). India's Plant Varieties and Farmers Rights Act aims to protect the rights of various actors, including the private sector, public sector and farmers. It is a unique legislation that grants legal rights to both breeders and farmers. This could lead to a system where multiple claims can be made on the same resource and ultimately discourage innovation.

IPRs currently do not pose a major obstacle to India's shrimp exports and do not prevent India from gaining access to material required for producing and exporting various shrimp species. However, this is likely to undergo changes if patents and other forms of IPRs become more applicable to aquaculture. In addition, the legal strategies currently utilized by aquaculture firms to protect their materials, branding and MTAs have inherent difficulties in offering protection. This could lead to greater demands for patents or other types of IPR protection for aquatic resources in future. The implications for India can be seen both through the extension of IPRs globally and the expansion of IPRs within India. SPF monodon programmes are currently being undertaken by various private and public actors and they could apply for IPRs on their materials.[28] India will have to pay high price for accessing such material if it is required. A study based on interviews among individuals focusing on fish breeding and farming in Norway revealed that stakeholders are becoming increasingly concerned with access and exclusive rights to the wild and improved breeding material that is central to their trade (Olesen et al., 2007). The global extension of patents could affect

shrimp aquaculture in India. If, for example, a major breakthrough related to breeding, selection or disease resistance occurred and was patented, it could have an impact on India in terms of affordability. Indian actors would have to obtain a license for using the technology and if the fees were extremely high, the technology would not be accessible to many stakeholders. If disease outbreak or radical climatic change occurs, it will become all the more urgent to access such materials to adjust the stocks to local farming conditions and systems. Tvedt (2013) provides an interesting example of a product patent on a pancreas virus registered in 1995, which covered not only the sample deposited but goes further by including the phrase 'closely related strains that have similar genotypical or phenotypical characters'. A case arose in relation to this patent where a company developed a vaccine of their own based on published academic research results but was the subject of a lawsuit, which challenged whether the strain was 'closely related' to the patented virus. According to Tvedt (2013) (p. 139), "The lesson we can draw from this particular case is that a patent on a virus can monopolise an entire field of research on similar viri. Not only does the patent protect research that the patent applicant could foresee at the moment of application, but all research on viri causing these symptoms. The patent also prevents the making of a vaccine from similar strains found in nature that were not known to the inventors at the time."

Domestically, with greater foreign collaborations in India, MNCs would push for extension of IPRs in several fields, paving the way for application of IPRs in aquaculture. A preliminary examination reveals that a few patents in India have already been granted to shrimp, including one for a microsatellite DNA marker used for identifying disease-resistant populations of *P. monodon*, and one for sequence of a portion of the genome of WSSV affecting shrimp (Ramanna-Pathak, 2012). Although patents in aquaculture to date have been few and related mostly to mechanical inventions, this could change in the future. The extension of patents to greater aquaculture related innovations would affect domestic industry, breeders and farmers. In the pharmaceutical patents sector, India has focused on access to medicines and has also issued compulsory licenses (a provision that allows a party other than the patent holder to manufacture the drug) to ensure medicines at affordable prices. The discussion in the pharmaceutical patent debate has focused on access to medicines for the poor, particularly in relation to diseases, such as HIV/AIDS. The debate on access to drugs in India has been influenced by the strong domestic industry pharmaceutical lobby. Whereas the overall discussions on access to medicines could impact the developments with regard to access to aquatic resources, it may be comparable only when the aquaculture industry in India is able to play a more prominent role in shaping policy. It might be possible to take some clues from the access to medicines campaign in framing a legal and political framework for the aquaculture sector that balances both rights and access to resources. Within the access to medicines campaign, the reduction or suspension of patents in certain cases was considered essential for meeting the needs of the poor. In the aquaculture sector, it will become important to find ways to ensure that certain resources remain a public good and provide adequate space for public sector investment in breeding. Convergence is evident with India's compliance with TRIPs, leading to extension of product products in pharmaceuticals and agriculture. India has also moved towards global standards by establishing plant breeder's rights to implement TRIPs. India's policy has progressed towards the ideology that IPRs are essential for promoting innovations in all fields, but divergence in relation to IPRs also exists.

Biological and Legal Protection Used by Companies in India

In tandem with global strategies, foreign companies in India are utilizing the same combination of biological and legal protection rather than patents to protect their material. These include selling narrow genetic base, cross between inbred lines and continuous improvement to protect their material. The mechanisms currently used by companies in India include continuous upgrading of the brood stock, contracts between collaborating multiplier hatcheries and seed producers and selling only PLs and not brood stock to prevent the genetic material from being propagated. These 'protection rings' have

implications for India in terms of access to resources. While not preventing domestic companies from producing or selling products, they restrict India's ability to be self-reliant. The protection strategies currently used by foreign companies create a situation of dependency for Indian companies requiring access to materials. This dependent situation essentially arises because Indian companies must continuously return to the foreign companies to access vannamei. Farmers require genetic material that can meet their specific goals and needs, such as adaptation to their specific environments or farming systems and conditions (Olesen et al., 2000; Gjedrem, 2005a). For example, inclusion of specific disease resistance traits in the breeding goal and selection programme may be crucial for sustainable farming practises (Olesen et al., 2000; Gjedrem, 2005b), For India to establish its own breeding programme, which is scientifically viable, it would require diverse founder population collected from various geographical locations.

Technological developments may lead to greater legal and biological control over aquatic resources. With the extension of IPRs, this could enable aquaculture firms to develop powerful protection strategies. Companies could also vary their strategies based on the markets in which they operate. Strategies used globally, such as branding, may also be applied in India. In addition, reproductively sterile shrimp and strategies and methods to control and document the origin of brood stock could be utilized by companies in the future. Biological and legal protection strategies could then pose a real obstacle to India in terms of access to resources and technology.

Monopoly Situations

The shift away from domestic reliance on one species, the black tiger shrimp, towards an exotic species, vannamei, signifies convergence with global developments. This paves the way for increasing collaborations between domestic and global companies and a greater role for multinational players in India. These changes lead to Indian industry becoming more dependent on access to these materials from abroad as vannamei is not native to India. The real barriers that India could face in future are those limiting its ability to establish a domestic breeding programme. Biological factors constitute one of the main limitations, but IPRs could also play a role in future. While several factors, including costs, research expertise and government support, may play a role, access to materials and technology in future could become an important factor with regard to vannamei since it is not a native species. Implications for access also arise with monodon as domestication and production of SPF monodon is not yet achieved by domestic actors at present. Access to resources, both with vannamei and monodon, is restricted for small companies and small farmers due to affordability. Access to vannamei is available only for those companies and farmers that meet the Coastal Aquaculture Authority guidelines and have adequate facilities.

The greater role for foreign companies in India's shrimp sector raises the possibility of certain firms capturing a large share of the market. Moana Marine Biotech currently has a monopoly in India with regard to SPF monodon. The monopolistic situation arising from the fact that one company is the sole supplier of SPF Monodon would have clear implications for the structure and competition in the shrimp sector in India. Moana Technologies is reportedly involved in a research project to develop GMO shrimps (Gura, 2009). GMOs are patentable, and this strategy may be important for the company to protect the genetic material (personal communication, senior scientist, Nofima).

In vannamei, although several companies are permitted to export to India, there is scope for large players such as Charoen Pokphand (CP) Thai to dominate the market. Charoen Pokphand or C.P. Aquaculture (India) is engaged in shrimp feed production, distribution and shrimp farming.[29] In Asia, the CP group is a major food processing and trading company, and CP has three main shrimp aquaculture companies with businesses in China, India, Indonesia, Thailand and Vietnam (Gura, 2009). CP controls approximately 18% of Thai shrimp exports, 60% of Thai shrimp feed market and is 31% owner of the single largest shrimp company in Indonesia (Gura, 2009). Globally, monopoly concentration in

aquaculture is perceived as a potential issue with regard to access to resources among stakeholders (Rosendal et al., 2013).

Public–Private Relations

India continues to promote a strong role for the public sector in aquaculture, but some convergence towards increasing privatization is also evident. Global developments indicate that publicly funded breeding programmes and breeder's lines are increasingly becoming privatized, and this could reduce access to global materials and resources for various actors in India, including industry, public sector institutions and farmers. An interesting case of divergence is India's IPR framework for public sector institutes. The public sector is encouraged to apply for IPRs, but those innovations, which are seen as necessary for public access would be transferred to the public domain. The Indian Council for Agricultural Research (ICAR) has laid down guidelines on how public sector agriculture research institutions should handle IPRs. The ICAR draft guidelines state, "IP management can prove to be a potent instrument for technology transfer to end users through public and private agencies, and cooperative sector. While not the major factor, IP management is also expected to bring in revenues to the ICAR through commercialization of technologies. After IP protection is secured as per law, case-specific decisions will be taken – based upon expediency of public need/ food and nutritional security — on whether a particular ICAR IP/ technology would be transferred for public access through commercial route or just dedicated for public use through open access." (ICAR Draft Guidelines, 2005) The public sector is faced with a serious dilemma in evolving a balance between IPRs and access. On the one hand, there is the mandate to widely distribute material in order to ensure access for all stakeholders, particularly the poor. On the other hand, there is the question of how to protect its own material from being copied and misused. The pressure to generate revenue and increasing trend of privatization of public resources complicates the issues further.

Access and Benefit Sharing

It is important to focus on India's Biodiversity Act as a means to ensure benefit sharing and prior informed consent with regard to aquatic genetic resources. However, implementing these provisions would not be easy, and India would also have to take precautions so that the Biodiversity Act does not act as a restriction on acquiring important technology (requires more focus on legal sources). Although ABS measures are not intended to create barriers between poor countries, the possibilities of restrictions on access acting as barriers for developing countries themselves may also arise. In the case of aquaculture, where developing countries are also dependent on access aquatic genetic resources from other nations (including other developing countries), this becomes all the more important. If India intends to establish its own breeding programme for vannamei, it will certainly require access to brood stock from other countries. In the case of monodon, although India can access brood stock domestically, it would need to collect brood stock from different geographic locations to produce SPF monodon in order to have a wider genetic base. The CBD principles have not yet been implemented to a large extent and, therefore, there may be no legal barriers at present to accessing foreign brood stock. However, with the implementation of the CBD, restrictions on access to wild populations of vannamei could create barriers for India to start a selective breeding programme for vannamei.

The NP can be useful in two ways in promoting greater balance between rights and access to resources. The first emerges from the possibility of evolving a Global Multilateral Benefit-Sharing Mechanism that is mentioned in Article 10 of the NP. The NP urges countries to consider the need for such a mechanism that could address cases where it is not clear whom benefits should flow to. In cases where it is not possible to identify the beneficiaries or in cases where there are many beneficiaries, this mechanism could be utilized. According to Tvedt (2014), the system has the potential to reduce some of the grey areas with regard to ABS and genetic resources. Such a mechanism could also find useful applications with

regard to aquatic genetic resources. A second way in which the NP could be utilized is the emphasis within the NP on recognizing the rights of Indigenous Peoples and Local Communities. According to Jonas et al. (2010), while Article 8(j) of the CBD establishes the right of communities to share in the benefits arising from the utilization of their traditional knowledge, the right of communities to benefit sharing arising specifically from third party utilization of their genetic resources is a major step forward in the NP (Jonas et al., 2010). The NP specifically mentions community protocols as a strategy that nations should adopt for promoting benefit sharing. According to some experts, this is a major step in recognizing community rights of self-determination (Jonas et al., 2010). A biocultural community protocol is a community-led instrument that promotes participatory advocacy for the recognition of and support for ways of life that are based on the customary sustainable use of biodiversity, according to standards and procedures set out in customary, national and international laws and policies (Jonas et al., 2010). Jonas et al. (2010) provide an example of a community using community protocols to engage in a participatory process where they defined the terms and conditions upon which they would share their knowledge and make that known through their community protocol. A local company responded to their terms, as opposed to it being the other way round as is the case with most instances of bioprospecting (Jonas et al., 2010). Subsequently, the healers resolved to enter into a non-disclosure agreement with a local company for bioprospecting (Jonas et al., 2010). The healers speak of this endogenous response to new challenges as having been empowering (Jonas et al., 2010).

Policy Options

India's strategy encompasses both convergence and divergence from global standards, and can be described as a policy of 'crossvergence'. Crossvergence is a term proposed by Ralston et al. 1993 used to bridge the differences between convergence and divergence schools. It can be described as 'in between' the values supported by the East and the West, suggesting that Asian organizations would develop a 'hybrid' model — blending the best elements of both their domestic and imported ideas (Abo, 1994 in Gupta and Wang, 2004). India has incorporated western notions of IPRs embodied in TRIPs, but has also reinterpreted and extended the logic of IPRs to genetic resources, farmer's varieties and traditional knowledge. India has also followed global trends in the shift from monodon to vannamei, but it has done so under controlled conditions, in a slow and regulated manner, with a very strong role for the public sector. India could attempt to continue on the path of crossvergence, extending this to aquatic resources by trying to focus on developing similar rights, such as farmer's rights for fish breeders, and by claiming benefit sharing over aquatic resources. India could also continue to promote both monodon and vannamei with strong regulations from the public sector over private sector activities. Regional approaches could serve as a model for evolving a framework of beneficial public–private relations. In Africa and other parts of Asia, regional cooperation in the field of ABS is being promoted. This holds lessons for India's approach to ABS. A positive aspect of the crossvergence strategy is that it could provide access to technology, as well as rights over genetic resources and encourage the growth of both the public and private sector. However, it could also lead to a situation where too many rights are being claimed by various actors. There would also be pulls for moving towards one of the two extremes, for example, NGOs who oppose IPRs would demand divergence, and multinational firms would promote convergence with global standards.

India could also adopt a policy response based on convergence by extending IPRs as a means of promoting innovation, encourage greater privatization of the aquaculture industry and focus on acquiring technology and improved aquatic materials from international sources. A strategy diametrically opposed to this stance, based on divergence, would restrict patents in aquaculture, focus on widely sharing and disseminating material, promote a more dominant role for the public rather than the private sector and emphasize indigenous shrimp over exotic species. Analysts supporting convergence would claim that it

would enable transfer of technology and boost innovation through IPRs. Proponents of divergence would debate this, pointing out that it would lead to dependence on foreign firms, that transfer of technology may not actually take place and that rather than encouraging innovation, it would enable aquatic resources to be exploited by global actors.

A final distinct approach we consider is transvergence. Transvergence aims to creatively change an organization's strategy through a reinterpretation and reapplication of indigenous culture and emergent market and technological opportunities (Gupta and Wang, 2004). Under this strategy, the goal would be to integrate global models with India's society and organizational culture. India could utilize both local aquatic resources and global technology to promote its industry. Rather than confining its policy choice of shrimp species only to vannamei or monodon, it could tap into indigenous species, such as indicus. India could strengthen its ongoing selection programme, so that it can produce its own superior germplasm, which would address the risk of disease and climatic changes. India could also ensure that it protects its technology, but at the same time, guarantee that such protection measures do not restrict access to the poor or have negative implications on other developing nations. The FAO ITPGRFA, for example, attempts to establish a list of crops on which countries agree to provide facilitated access to genetic resources. Although the treaty deals exclusively with agriculture and is facing difficulties in implementation, it provides some grounds for fostering innovative approaches to ensuring a balance between access and rights over genetic resources. As Gupta and Wang (2004) point out, the transvergence approach focuses on strategy, culture and technology not as opposing forces in the globalization process, but rather than complementary factors in creating new organizational foundations for competitive advantage.

Conclusion

Globalization of the aquaculture sector is taking shape rapidly, but the responses to globalization need not follow one model. India's policy cannot be categorized as only convergence towards a universal model nor complete divergence. India's policy exhibits both convergence and divergence and reinforces the idea that both convergence and divergence can occur simultaneously. This convergence–divergence strategy in relation to aquaculture may be pragmatic at present, but this strategy could also be difficult to implement and could lead to multiple claims over resources, thereby thwarting innovation. Rather than considering a move towards convergence or divergence, this paper points out that a strategy of transvergence could hold possible lessons for India (see policy options above). Transvergence aims to integrate global models with India's society and organizational culture. This strategy could focus on promoting India's indigenous aquatic species, as well as India's domestic breeding programme. India need not follow one model or completely digress from global standards; rather it could evolve a strategy suited to its own needs.

India has options that it can pursue in establishing its policy on IPRs and access over aquatic genetic resources. A significant window of opportunity exists for India with regard to IPRs and aquaculture as global protection mechanisms in aquaculture are still evolving and strong measures such as patents have not yet been extensively applied to aquatic resources. India can draw lessons from the expansion of IPRs to agriculture and pharmaceuticals and the conflicts over access to seeds and medicines taking shape worldwide. However, India must act fast and cannot afford to ignore global and national developments with regard to ownership of aquatic resources. The case of salmon in Norway illustrates how quickly situations can change and place an industry in a position where it may become dependent on external companies and must pay royalties for using interesting genetic material that originated within Norway itself (Olesen et al., 2008). Options even in this case could have been pursued, such as retaining public shares or reorganizing the programme under a cooperative or state-owned framework (Rosendal et al., 2013). Currently, stakeholders in the aquaculture sector do not have a clear perception regarding the implications of restrictions on access. Yet it is evident that limitations on access to wild populations of

exotic species could pose a serious challenge to the growth of the Indian shrimp sector. India should adopt a preemptive strategy and ensure that important aquatic genetic resources found in India continue to be accessible to stakeholders. The Indian shrimp sector is at a crucial juncture, moving towards greater globalization and integration with international markets, and therefore cannot afford to neglect the issue of IPRs and access to aquatic genetic resources.

Acknowledgments

This study was conducted as part of the project on 'Improved Disease Resistance of Tiger Shrimp and Rohu Carp Farmed in India: Developing and Implementing Advanced Molecular Methods, and Streamlining Access to Use of Genetic Resources' (Project number 183833). Funding and support was provided by: Research Council of Norway, Department of Biotechnology, India, Nofima and Fridtjof Nansen Institute. I would like to gratefully acknowledge the assistance provided by scientists at the Central Institute of Brackishwater Aquaculture (CIBA), India. Sincere thanks to Mr. Krishnan who shared his vast experiences regarding the industry and also introduced me to the major stakeholders. I am indebted to Dr. Kristin Rosendal and Dr. Ingrid Olesen, for always providing enormous support, reading several drafts, and providing valuable comments. Many thanks to Dr. Nick Robinson for his assistance in coordinating various meetings that enabled the project to move forward. I would like to express my gratitude to Dr. Jeroen van Wijk who introduced me to the theoretical literature on convergence and divergence. I would also like to thank an anonymous reviewer for providing excellent comments. The contents remain the sole responsibility of the author.

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Notes

1. http://lexicon.ft.com/Term?term=globalisation.
2. http://www.economist.com/node/1974450.
3. http://www.economist.com/node/1974103.
4. http://faculty-staff.ou.edu/R/David.A.Ralston-1/crossvergence.pdf.
5. Webber (1969) quoted in Ralston (2008). http://faculty-staff.ou.edu/R/David.A.Ralston-1/crossvergence.pdf.
6. http://www.mpeda.com/inner_home.asp?pg=aquaculture/contents.htm.
7. http://www.mpeda.com/inner_home.asp?pg=aquaculture/contents.htm.
8. www.fis.com.
9. Dr. Paulraj, 'Revitalising Indian Aquaculture' Key note address at Progress and Profits in Indian Aquaculture, AquaIndia Conference, 29–30 October 2010.
10. Ravichandran and Ponniah unpublished draft (2010) outline various stages of the shrimp sector's development in India. The first phase (pre-1988–89) was a period of low risk and low profit where shrimp farming was based on traditional methods dependent on wild seed with an absence of commercial hatcheries. In the second phase (1989–95), hatcheries were set up; semi-intensive culture was practiced, which led to a low-risk high-profit model. The

year 1995 marks the beginning of the third phase when the shrimp industry was plagued with disease. This phase can, thus, be seen as one of high risk. The fourth phase (2006–2008) witnessed a drop in global shrimp prices, and the industry faced anti-dumping duties, strict food-safety standards and moved to a period of low profit. After 2009, the global prices have improved and with the production of vannamei in 2010, it has become more profitable.

11. http://www.agriculture.de/acms1/conf6/ws9fish.htm.
12. http://www.fao.org/fishery/topic/13275/en.
13. Thanks to an anonymous reviewer for elaborating on this point.
14. TRIPS Article 27.3(b) allows WTO members to exclude "plants and animals other than micro-organisms and essentially biological processes for the production of plants and animals other than biological and microbiological processes," provided that they offer patents or establish "an effective *sui generis* system" of protection for plant varieties (Grain, 2001).
15. http://www.iphandbook.org/handbook/ch04/p05/
16. http://www.iphandbook.org/handbook/ch04/p05/
17. Thanks to an anonymous reviewer for pointing this out.
18. Although aquaculture is not specifically mentioned in India's Patent Act, it is clear that the law did not provide for patenting of animals or plants or processes related to treatment of animals or plants. The act stated that the following is not considered an invention under the Act: "any process for the medicinal, surgical, curative, prophylactic or other treatment of human beings or any process for a similar treatment of animals or plants to render them free of disease or to increase their economic value or that of their products".
19. According to Briggs et al (2004), "SPF means that the animals have been assured of being free from specific pathogens. This does not, however, guarantee against the animal being infected with unknown pathogens or known pathogens which are not screened against. SPR or Specific Pathogen Resistant describes a genetic trait of a shrimp that confers some resistance against one specific pathogen. SPF and SPR are independent characteristics and not all SPR shrimp are SPF and vice versa" (Briggs et al, 2004).
20. http://aquagen.no/en/about-aquagen/owners-and-board/.
21. Business Line 3 February 2009.
22. Interview, Indian policy maker, 21 July 2010.
23. Ibid.
24. http://library.enaca.org/AquacultureAsia/Articles/Oct-Dec-2007/aa-oct-dec-07-moana.pdf
25. http://nfdb.ap.nic.in/pdf/AnnualReport2007-08-NFDB.pdf
26. http://nfdb.ap.nic.in/pdf/AnnualReport2007-08-NFDB.pdf.
27. http://goliath.ecnext.com/coms2/gi_0199–7833797/Empowering-farmers-towards-sustainability-and.html.
28. The current SPF monodon programs include: Moana, Unima group (Aqualma farming operations) based in Madagascar, CP group (Thailand), CSIRO, France Aquaculture (previously developed but do not hold any stocks now), Rajiv Gandhi Centre for Aquaculture, MPEDA, India, Thailand CP Indonesia (stocks in Hawaii), Highhealth (have SPF stocks but not sure if there is a continued breeding program going on), Black Tiger Aquaculture, Malaysia (by Integrated Aquaculture International, IAI — abandoned), Department of Fisheries, Brunei Govt. (in collaboration with IAI). (Rao, Manuvendra, "Emerging Trends in SPF *P. monodon* programme-performance and commercialization, General Update on Domestication", presented at the AquaIndia 2010 conference Progress and profits in Indian Aquaculture, Chennai, October 29–30, 2010).
29. http://www.mycpindia com/.

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